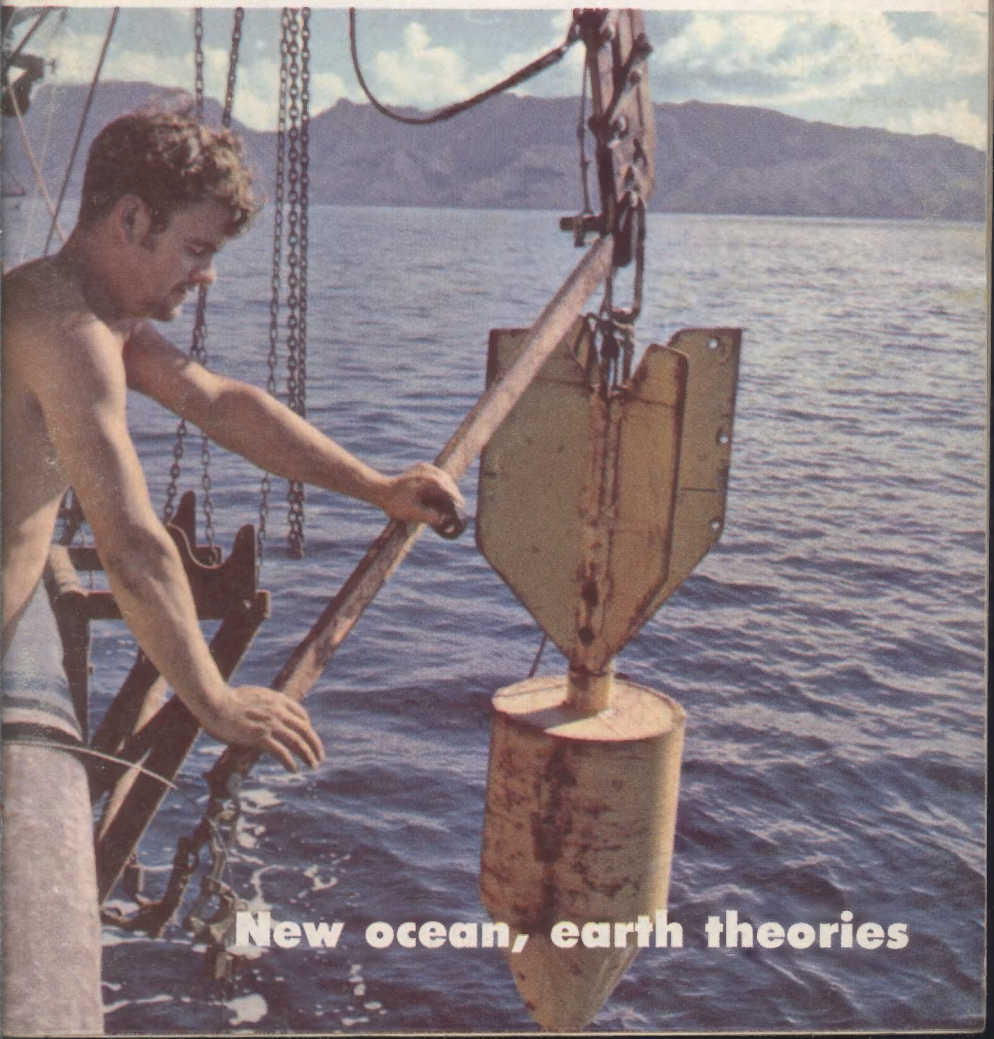
APRIL 1963 35 CENTS ICD

SCIENCE DIGEST

ARE WE DRINKING TOO MUCH MILK?

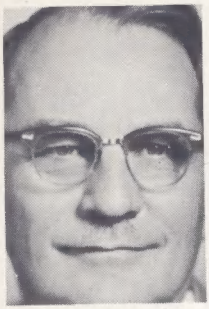
WHAT OUR H-BOMBS DID TO SPACE

How heredity affects your health

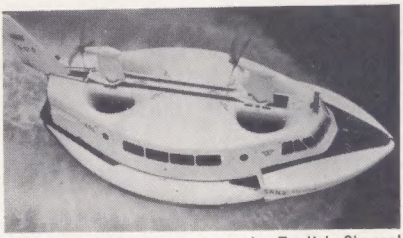


New ocean, earth theories

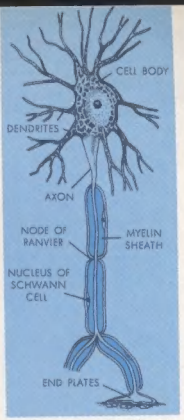
In this issue . . .



We must understand our differences as well as our similarities says a noted biochemist: Key to health: Your heredity.

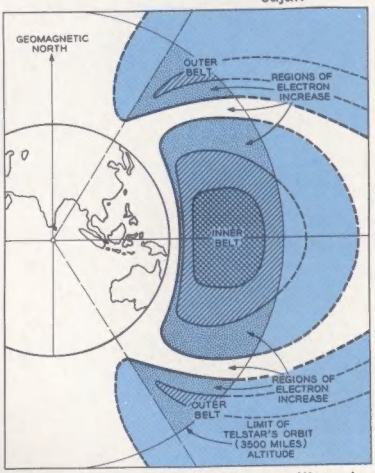


How would you like to cross the English Channel on thin air. The British, who lead in the development of Hovercraft vehicles, are now testing such a service and planning other uses for this form of transportation: Your ticket to air cushion travel.



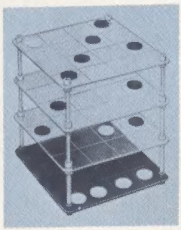
A Spanish scientist revealed the structure of the nervous system: A Science milestone: Santiago Ramon Y Cajal.

This toothy monster once ruled the ancient seas. Recently a farmer plowing his cotton field ran across the fossilized remains of the creature: Alabama boneyard sheds new light on whales.

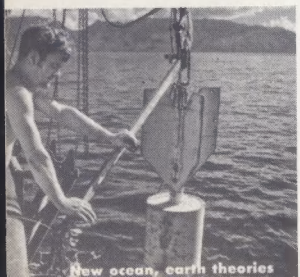


Telstar, the communications satellite, has done more than send pictures across the ocean; it is used to measure radiation: Recent nuclear blasts boost space radiation hazard.

Goma will be to gorillas what Elsa is to lions: the oft-photographed darling tended as a member of a human family. Goma means "dance of joy": Books.



Qubic, a tic tac toe game that played in three dimensions: Inventions, Patents. Processes.



New ocean, earth theories

The Cover This Month

A crewman of the oceanographic ship Vema prepares to lower an ocean bottom corer during one of the Vema's recent scientific cruises. The corer brings up samples of sediment from the sea bottom and also contains instruments for measuring temperatures within the cores. The temperatures are an important clue to understanding heat flow within the earth. —Photo. Dr. Bruce C. Heezen.

SCIENCE DIGEST

Twenty-seventh year of publication

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ELLIS MOTT, *Editor*

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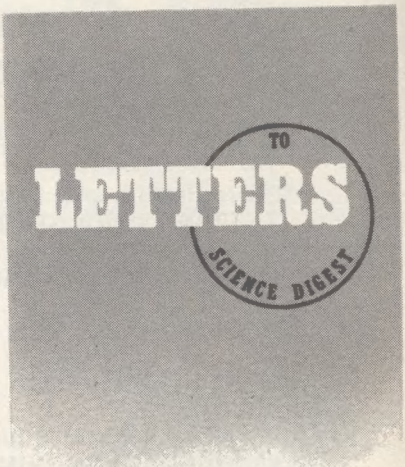


Ash Tray Kalah

Would you be so kind as to forward me the information as to where I can purchase one of Mr. Champion's kalah boards?

I understand . . . that he is the country's sole manufacturer. Since the article appeared ("Old African Numbers Game," January '63), my fellow engineers and I have been playing the game with ash trays and cigarette butts; but, as you can imagine, this is a most unsatisfactory way . . . as some of the butts are still lit, and the players insist on picking them up for one last drag. Also chain smokers take unfair advantage by slyly depositing fresh butts in their scoring bin. In the interest of keeping this game honest, I hope you can help us.

F. L. WILLIAMS
Sanford, Michigan

Inquiries about the purchase of kalah boards should be sent to the Kalah Game Co., 27 Maple Avenue, Holbrook, Massachusetts.—EDITOR.

Wrongly Accredited

In your January issue of *Science Digest* in the article, "Coon Creek's Fabulous Fossils," by Allan W. Eckert, is the statement and I quote, ". . . individuals who wish to collect fossils for themselves . . . are urged first to write the Memphis Museum of Natural History and receive written permission. . . ."

For your information the Memphis Museum has no control over the Coon Creek Area, and at no time has indicated as much to Mr. Eckert. . . .

MRS. RUTH C. BUSH, DIRECTOR
Memphis Museum
Memphis, Tennessee

I regret this misinformation. In visiting Coon Creek last summer, I had some difficulty finding the place. Asking for directions at a nearby farmhouse, I was told how to find this property, but that I would have to have permission from the Memphis Museum to enter it. Signs on the property seemed to corroborate this. I took it for granted that the information was correct.

ALLAN W. ECKERT
Dayton, Ohio

Space Ship in Siberia?

I would like to comment on the item "Soviets Propose New Theories for Siberian Explosion of 1908." (Science Around the World, November '62). The answer is in the hands of the Russian scientists. If they dig deep enough in the area of the depression, I am sure that they will indeed be surprised to find a petrified spacecraft from another planet, or to be more accurate from the earth's sister planet behind the sun!

MOSES FERNANDEZ, JR.
Laredo, Texas

Seaborg the Chemist

In the future when you have occasion to publish a piece on Dr. Glenn T. Seaborg as you did in your December '62 issue ("Letter to a Young Scientist") will you call him a chemist rather than a physicist. I am told that in the field of nuclear energy the boundary lines between disciplines are a little vague, but the fact remains that Dr. Seaborg is a chemist and, to the best of my knowledge, so describes himself at all times. He received the Ph.D. in chemistry from the University of California at Berkeley, taught chemistry there for many years, and won the Nobel Prize in Chemistry in 1951. He has long been an active and valued member of the American Chemical Society.

One reason we feel rather strongly about the designation of Dr. Seaborg as a physicist is that he is one of the outstanding chemists we like to cite to young people when we are trying to show them how important the work of chemists is in virtually every field today.

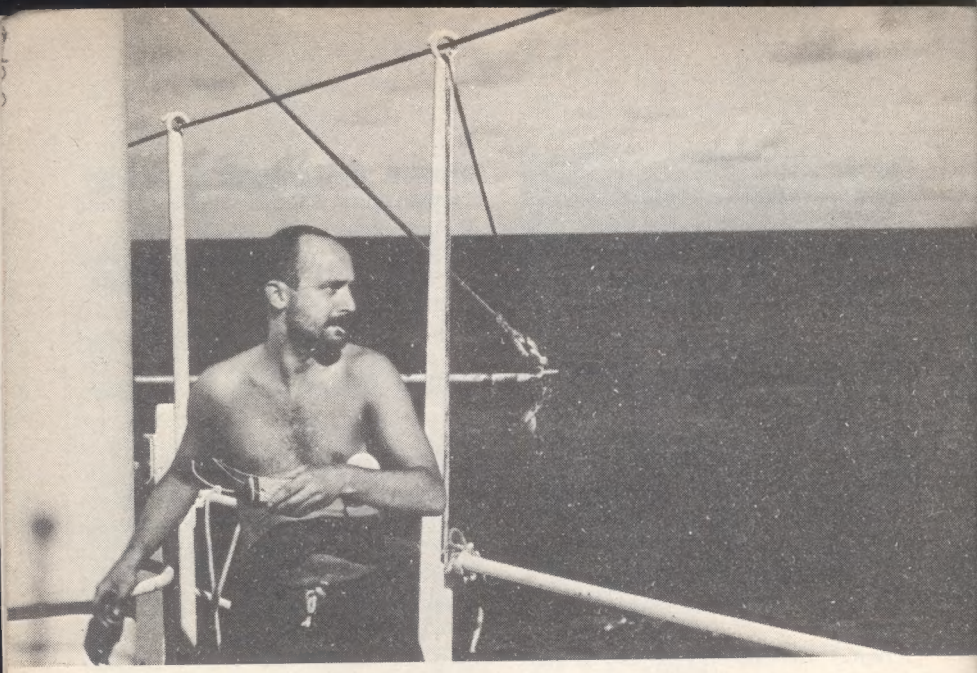
JAMES H. STACK
Director, Public, Professional
and Member Relations Division
American Chemical Society

Not Clear

In "Can Science Offset the Population Explosion?" (February '63) I think I understand that Dr. Weinberg is worried about the "population explosion," despite the much qualified but generally optimistic statistics regarding resource supplies.

Could it be that Dr. Weinberg has worked for the government too long and has forgotten how to say things clearly and concisely? *Science Digest* has published many worthy state-

(Continued on page 71)



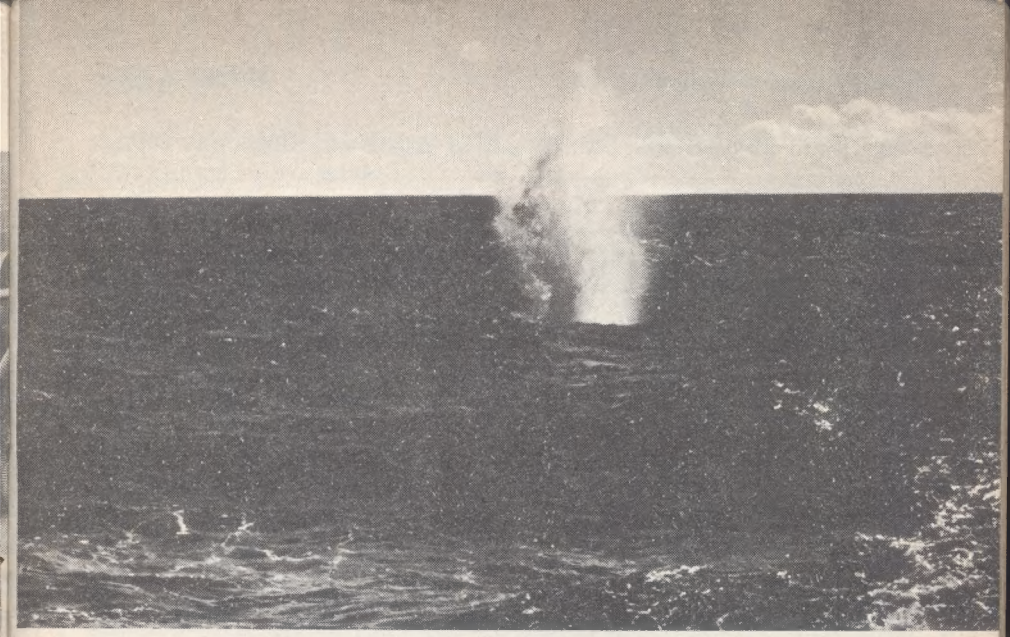
Ocean's maps and earth theories revolutionized by latest findings

We know more about the surface of the moon than we do about the bottom of the sea. At least an astronomer can look at the moon. Today, however, new techniques allow scientists to "look" at the ocean bottom. They are helping us solve the puzzle of how the earth was formed.

by Dr. Bruce Heezen
as told to Bruce H. Frisch

SOUND is to the oceanographer what light is to the astronomer. The astronomer can observe stars billions of light years away. The oceanographer, however, cannot see the bottom one mile under his feet, and below 5,000 feet there is total darkness. So he uses sound and other new techniques like measuring heat flowing from the earth. These and new money have spurred a boom in oceanography.

Before World War II, the oceans were vast unknowns. Since then we have learned practically all we know about the oceans. Perhaps I



Aboard the three-masted schooner, Vema, used as a research vessel by the Lamont Geological Observatory, a crew member hurls another charge of TNT into the ocean. By recording the reflection of the sound on a chart, observers on board ship can picture the contours of the ocean bottom beneath the layers of soft sediment that cover it.

can best illustrate the new techniques, which have contributed a great deal to our knowledge of the oceans, by telling how they have been used in the discovery of the Mid-Ocean Ridge and rift and the growth of the expanding earth theory, work I have been connected with.

Although the Ridge is one of the three major surface features of the earth, along with the continents and ocean basins, it lay hidden from view beneath the oceans until very recently. Part of the Ridge in the mid-Atlantic showed up from soundings made by the British oceanographic ship *Challenger,* in 1873. These soundings were made by lowering a 200-pound weight on a hemp line to the bottom of the ocean floor. In this way, the depth at one single point on the vast ocean floor was determined. The method was comparable to a blind man feeling his way around with a miles-long cane. By such a slow method, the *Challenger* could afford to make soundings only every 100 miles. Yet even with so few soundings, a rise was apparent where previously there was thought to be a flat plain.

During the '20s ships began using echo-sounding gear. The modern version is the Precision Depth Recorder, a scientific model of the cruder, less accurate fathometer. Pointing down from the bottom of the ship is a transducer, or loud-

speaker, into which is fed a 12,000 cycle per second pulse, a high note in the audible range. The bottom reflects a tiny portion of this sound energy back to the transducer, which then acts as a receiver. A moving pen records the echo on graph paper calibrated in time between sending the pulse and receiving the echo. Knowing that sound travels through sea water at approximately 1.5 kilometers per second, one can convert travel time into depth.

As the ship moves along, the pen traces a profile of the bottom. The result is a continuous series of depths along a line, better than the single points obtained by rope. But just one profile can be very confusing. A high spot on the profile can be a single peak, a long mountain system, or the face of a cliff. If it is part of a mountain range, there is no way of telling which way the mountains run. It takes many profiles plus imagination to fill in the gaps between the lines before a picture emerges.

By 1953 there were enough profiles taken to make a topographic map of the Atlantic. While preparing such a map, my associate Marie Tharp, at Columbia University's Lamont Geological Observatory, where I work, discovered that the Mid-Atlantic Ridge was carved down the center by an unsuspected rift, or valley. Several other ridges were known at the time, but all were thought to be isolated. This idea soon changed as another piece of evidence gathered with sound fell into place, the locations of earthquakes.

Oceanography's Sound Spectrum

In the spectrum of sound used in oceanography, the 12,000 cycles per second of the PDR is at the high end. Earthquake waves on the order of five cycles per minute are at the extreme low end. Not only can't they be heard, they can't be felt. Still, they are sound waves in the same sense that invisible infrared waves are light.

Earthquakes send out three main kinds of waves. P waves travel straight through the earth and are the fastest, so arrive first at a seismograph. S waves also travel straight through the earth, but are slower than P waves, so arrive second. Surface waves take the long way around, so arrive last. The time between the different arrivals tells how far the earthquake is from the seismic station. The seismologist at that station can then draw a circle around his station and say the earthquake occurred somewhere on that line. Two stations narrow the possible location to two points at the intersections of two circles. A third station spots the quake within a small triangular area.

Over the years, plots of many

A native of Iowa, Bruce Heezen received his B.A. from the University of Iowa in 1948, his M.A. in geology from Columbia in 1952, and his Ph.D. from the same university in 1957. Dr. Heezen is interested in the geological, geophysical, and oceanographic exploration of the deep sea.

The Rift Valley of the Mid-Atlantic Ridge

The solid line represents the rift valley of the Mid-Atlantic Ridge, whose extremities are marked by the broken lines.

earthquakes had fallen in a 100-mile-wide band down the center of the Mid-Atlantic Ridge and on around the world in a 35,000-mile-long line through all the oceans. On this basis, Dr. Maurice Ewing, director of Lamont, and I predicted in 1956 that there was a worldwide rift following the line of earthquakes and a ridge associated with it.

Underwater Mountain Range

Since then further soundings have shown the Mid-Ocean Ridge to be a long, wide mountain range. Along much of its length, it generally follows the outlines of the continents and lies in the middle of the oceans separating them. In the North Atlantic, it is about 1,200 miles wide, taking up one-third of the ocean floor. Broad, flat basins lie on either side. The crest of the Ridge may be 12,000 feet above the basins, and the rift 6,000 feet deep and eight to 30 miles wide. These figures are representative only. Naturally, there is a lot of variation in height and width of the Ridge and in prominence of the rift over 35,000 miles. The Ridge emerges from the oceans to cross Iceland and East Africa and sends splinters through California and into New Zealand, Siberia, Alaska, and Chile.

Although important in charting the ocean floor, a depth recorder is able to provide only the most superficial information. Corers bring up direct evidence of the composition of sediment, and dredges bring up rocks. Yet both have to be lowered miles down through the ocean for one sample, and the deepest cores reach only 100 feet into the bottom. Again sound is the solution. The lower the frequency, the deeper sound will penetrate. The PDR's 12,000 cycles per second doesn't penetrate much at all. Frequencies on the lower borderline of the sense of hearing, from 25 to 60 cycles per second, reach through sediments to hard rock.

Some sound bounces back from the top of the soft sediment, and some continues on to bounce back from a smooth, more solid layer of sediment or volcanic ash. Very little sound gets beyond a layer of hard and extremely rough rock underlying the sediments. The instant each reflection returns to the ship, it is recorded on a chart. The resulting profile is like the one from the depth recorder except that there is one line for each layer the sound reaches, normally the three mentioned.

Pushing sound through sediments takes more energy than a loudspeaker can supply. Instead, one of the scientific crew tosses a one-half or one pound charge of TNT (trinitrotoluene) into the water. Most of the work with seismic reflections has been done by the *Vema,* a three-masted schooner used as a research vessel by Lamont. During her last cruise, which ended in December, 1962, the men aboard made a continuous profile around the southern oceans. This meant exploding a charge every two or three minutes,

night and day, for a year and a week as the Vema cruised a 56,000 mile track. The tons of TNT necessary present a safety and supply problem, and the handling limits the rapidity with which points can be taken.

To get around these drawbacks several other methods have been tried. In one system, a mixture of propane and oxygen or air is ignited in a chamber open to the sea. In a second system, an electrically charged condenser bank discharges through a cable trailing in the water. In a third system, called a boomer, two aluminum plates are forced apart by electrical repulsion and snap together again. Each system has its own drawbacks, and none puts out as much energy as TNT. The explosive will still be around for a while.

Sediment Blankets Shown

Profiles taken by seismic reflection show that along much of the Ridge there is a thin, variable blanket of soft sediment. Much thicker sediments fill the adjoining basins. Along its central hundred miles, the Ridge is almost bare.

Strange as it seems, if both basin and Ridge are of equal age, the sediment should be much thicker on the Ridge. It is not, because sediment in the deep ocean comes from two sources: fine dust blown or carried by currents from land, and debris from dead sea animals and plants, much of it calcium carbonate shells. Both fall to the bottom at the same rate on basin and Ridge. The calcium carbonate, however, is dissolved by water rich in dissolved carbon dioxide. There is so much more carbon dioxide in deeper, colder water, that the net rate of sedimentation on the Ridge is ten times higher than in the basin. My conclusion is that the Ridge is probably younger than the basins.

Further speculation about the Ridge requires more information, for which we must dig deeper into the ocean floor. As mentioned before, lower frequencies penetrate further. To get beneath the layers of sediment pierced by seismic reflection, it is necessary to use the next lower frequency range, from six to 30 cycles per second. This range extends downward from the lower limit of human hearing.

Seismic refraction, as the technique is called, takes two ships and much more time to carry out than reflection. One ship sits dead in the water as silent as it can be and listens, while the other ship steams away in a line dropping TNT. Nearby, the shooting ship drops three pound charges. At the end of a 25- to 60-mile run, the charges are as large as 350 pounds.

Each layer the sound penetrates is denser than the one above and, therefore, carries the sound at a higher velocity. Just as light is bent as it passes from air into a glass lens, so sound waves are bent, or refracted, as they pass from a layer of lower density to a layer of higher density. As a result, some sound turns in a horizontal direction with-

in a layer. While the sound travels horizontally, small amounts are constantly hitting the upper surface of the layer and being bent upwards. These faint remnants the listening ship picks up on its hydrophone.

At the exact instant of explosion, the shooting vessel signals the listening ship by radio. Sound from the densest layer arrives first at the listening ship, followed by that from the less dense layers in turn, and finally by the direct waves through water. The time between the arrival of the radio signal and the direct wave tells the listening ship its distance from the explosion. Comparing travel times through the rock layers with the distance the sound has travelled, scientists can tell how deep the layers are and how fast sound travels in them. Sound velocity, in turn, is a good clue to what material is in a layer.

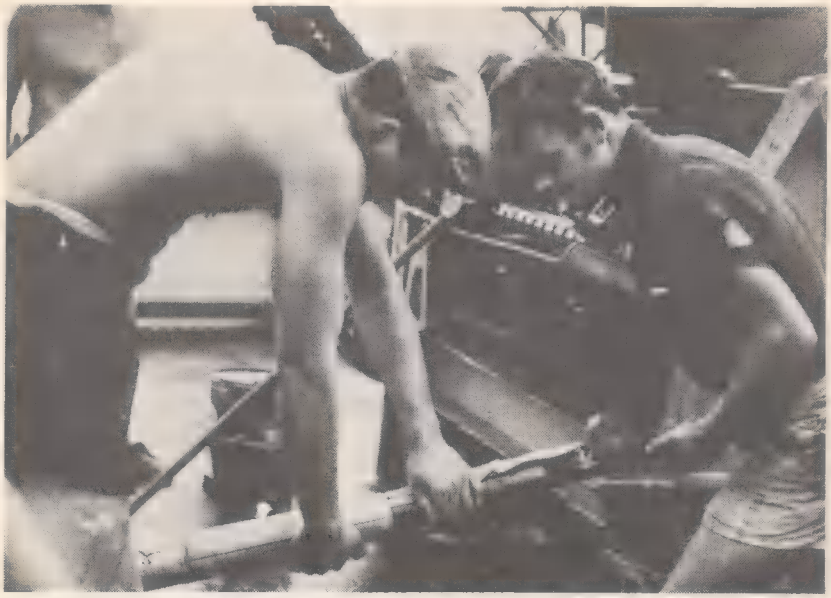
Measurements of Earth's Crust

Evidence from seismic refraction shows that the earth's crust under the oceans is only three miles thick, compared to over 20 miles under the continents. Studies of earthquake waves indicate a solid mantle of different composition extending from 20 miles to 1,800 miles, beneath which is a liquid core. There may be a solid inner core in the liquid core from a depth of 3,100 miles to the center of the earth about 4,000 miles down. Most radioactive isotopes of elements are in the crust. The chief ones are uranium-238, uranium-235, thorium-232 and potassium-40. Their slow decay heats the crust, resulting in a constant heat flow toward the cool surface. Since the ocean crust is thinner, there should logically be less radioactive material and a lower heat flow there. In fact, heat flow from below the oceans is about the same as through the continents, a puzzle for which no one has an adequate explanation.

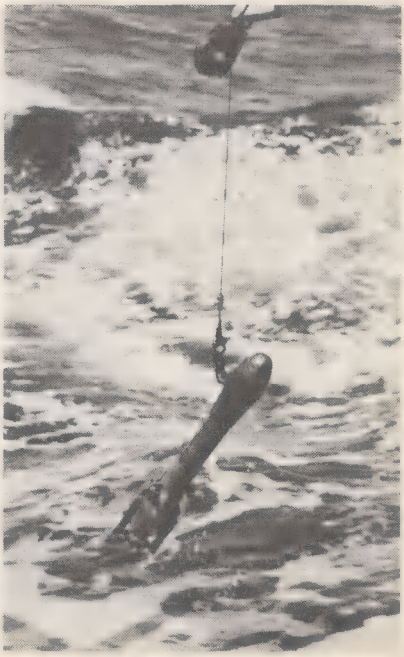
Heat flow through the rift is up to eight times higher than the world average. Before I say why I think that is so, let me explain how we measure heat flow.

Heat flow is proportional to the temperature drop between hot interior and cold surface. More heat will flow through a material that conducts heat well than through one that does not. The process is analagous to an electric current passing through a conductor. The greater the voltage difference across the conductor, and the higher the electrical conductivity of the conductor, the larger the current. Heat flow is like current; temperature difference, like voltage; and thermal conductivity, like electrical conductivity.

Thus there are two things to measure in the ocean floor, temperature gradient and thermal conductivity. The measuring instrument used is a 20- to 40-foot length of two-and-one-half-inch diameter pipe with a 1,200 pound weight at the top. Along the length of the pipe are five thermistors, electrical resistors whose resistances change with temperature. The pipe is lowered by cable close to the bottom



The composition of the ocean bottom can be learned by drilling, then removing, cores from the ocean floor. Aboard the Vema, cores were stored in protective cylinders like this one until they could be more thoroughly examined.



One of many recording instruments that can be used by a research vessel in motion, the bathythermograph automatically records the temperature of the water through which it is being towed.

and dropped so that it sticks in the sediment. A self-contained instrument package on the corer records on film the temperatures read by the five thermistors. Later the core of sediment jammed inside the pipe is measured in a laboratory for thermal conductivity.

Volcanic activity along the Ridge could explain the high heat flow there, just as it explains the high heat flow found in Yellowstone

Park, and other similar areas. I believe, instead, that the earth once had a shell of uniformly thick crust. Expansion of the earth split the crust into continental blocks. As the continents drew farther apart, hot mantle material welled up through the widening rift and formed thin, new crust as needed in the space between, which had become the ocean floor. This would account for the high heat flow, the apparent youth of the Ridge shown by its thin sediment cover, and the movements causing earthquakes under the Ridge.

The alignment of iron minerals in rocks of different ages seems to prove both that the earth's magnetic pole has wandered and that the continents have moved. In addition, surface cracks in Iceland, where the Ridge and rift cross dry land, are parting at the rate of 3.5 meters per thousand years for each kilometer of width.

Two things may cause expansion. The British physicist P.A.M. Dirac has proposed that the force of gravity decreases as the universe grows older. With the relaxation of the force holding the material of the earth together the earth could grow. R. H. Dicke of Princeton calculated the possible expansion, which could have been enough to account for the present area of the Ridge. Further expansion could come from the change of dense liquid core material to less dense material of the solid mantle.

This is only a brief outline of the expanding earth theory. There are also theories of continental drift, convection currents in the mantle, and a shrinking earth. In any event, the outline serves to show how new facts about the oceans and the new techniques for gathering these facts are affecting thinking about the puzzle of how the earth was formed. Until recently scientists have been trying to solve the puzzle with two-thirds of the parts missing, the two-thirds of the earth covered by the oceans. I hope that on *Vema's* present cruise, begun in February, we can fit a few more pieces into place.

RELIABLE FLOOD FORECASTS POSSIBLE WITH RADAR

EVER SINCE NOAH, man has been seeking reliable methods of flood forecasting. And now, with the help of radar, he may have found it.

Radar is already widely used in meteorology to locate rainstorms. A single radar unit can generally scan a watershed, the land basin that catches a river's supply of water, and draw on the viewing scope a picture showing the precipitation in its range.

In the new flood forecasting system, these continuous radar reports of rainfall are recorded over an extended period so that the accumulated total inches of rainfall is measured. The system, called the Precipitation Integrator, was developed by Ronald T. H. Collis, head of the radar aerophysics group at the Stanford Research Institute which is located in Menlo Park, California.

Of all the busy insects, the hardest working is

The wood-boring carpenter bee

by Allan W. Eckert

THE carpenter bee, *Xylocopa*, is one of the largest and most powerful bees in the world. For a period of nearly six weeks each summer, the female works on a single project that so consumes her she seldom takes time to eat.

Often when first seen, *Xylocopa* (meaning "wood-cutter") is incorrectly identified as the common bumblebee, *Bombus*. Although the carpenter bee tends to be a little larger—usually an inch or more in length—both bees have the same

A carpenter bee enters the burrow.

bulky, unstreamlined shape. The carpenter bee, however, flies considerably faster than the bumblebee. The overall yellow-and-black coloration of both insects contributes to the cases of mistaken identity.

Bombus is somewhat hairier, with a black head and legs and clear purplish-brown wings. Directly behind its head is a heavy ruff of bright yellow fur, followed by a deep band of black fur about the middle. Another band of heavy yellow fur begins on the forward portion of the rounded abdomen, with the posterior portion once more a deep black fur.

In the female carpenter bee, on the other hand, while head and legs are black, the entire thorax is yellow or whitish fur except for a small, dark, basically hairless spot in the dorsal center of the thorax.

The Striking Difference

The most striking difference, however, is in the abdomen which, for the carpenter bee, is considerably flatter, dorsally hairless and a glossy blue-black almost like the shell of a beetle. Occasionally there is a very thin band of yellowish or whitish hair on the abdomen where it joins the thorax.

Male and female bumblebees are similarly colored, but the male carpenter bees are frequently colored greenish-yellow. Finally, the female carpenter bee has a dense brush of hairs on the hind legs for carrying pollen instead of the "basket" used by bumblebees.

The strength of the carpenter bee's jaws is phenomenal. You may have noticed fence posts, grape-arbor poles, logs, stumps, porch pillars, barn rafters, and other building timbers with smooth, half-inch diameter holes bored in them. These holes are so round and neat it seems they must have been made with a wood drill or auger. This is the work of the carpenter bee.

The Female Bee

When spring arrives, the female *Xylocopa* leaves her winter hibernation and spends several weeks busily feeding. This feeding is done by chewing through the base of flowers and using the long tongue to get at the nectar, rather than always entering the opening of the blossom as does the bumblebee.

During this period the female is approached by the only slightly smaller male. At first she accepts his attentions and allows herself to become fertilized. Soon after, however, she has little time for him. The male, however, doesn't realize this and continues to pester her. The female's disposition grows rapidly more sour; and if he persists in accosting her, eventually she attacks him savagely. The male finally realizes this is no game and flees before she can cripple or mortally wound him.

Having given up, he now spends the remainder of the summer buzzing aimlessly about in search of nectar and companionship among other rejected males. These males

usually stay near the burrow of their origin and at night huddle together for warmth in cracks and crevices.

The female, meanwhile, finishes her heavy feeding and sets about searching for an ideal spot for her eggs. It is now early May. The spot selected generally turns out to be a hard, dry dead tree branch or fence post. She may spend several hours crawling up and down the wood she has chosen, inspecting it minutely from one end to the other. When satisfied it is right, she begins work.

The bee's massively muscled jaws chew rhythmically at the wood. Little by little a mound of fine sawdust accumulates on the ground beneath. In most cases, she will not dig into soft wood. In fact, it almost seems that the harder the wood, the better she likes it. Close-grained, well-seasoned oak, hickory, ash, and elm are favorites.

The initial tunneling normally goes straight into the wood across the grain for a distance of one-half to one and one-half inches, then makes a right-angle turn and continues with the grain for a distance up to two feet—though usually in the vicinity of 12 to 18 inches. Sometimes side galleries, excavated parallel with the main tunnel, use a common opening.

The cross-grain digging of the first part of the tunnel takes two to four days. Up to six weeks is spent on the remainder, where the bee carves at the rate of about a half-inch per day.

If a man were to do the same amount of work in proportion to size, he would have to bore a 90 foot tunnel two feet in diameter into a hard, well-seasoned log, with his teeth.

The tunnel carved by the bee is symmetrical and seldom more than a half-inch in diameter. Sometimes during these strenuous labors she becomes so exhausted that she passes into a comatose state lasting for hours, her jaws still locked on a bite of wood. Recovering, she continues as if nothing had happened. The sound of her gnawing carries for several feet. At night she rests in the gallery.

Gathers Nectar and Pollen

As soon as the tunnel is finished, the female gathers nectar and pollen. At the deepest recess of the excavation she chews it into a honey-pollen paste, forms a loaf of bee's bread about a half-inch long and as thick as a pencil, and then deposits alongside this a huge egg nearly the same size.

To complete the egg chamber, the bee now becomes an adept mason. She mixes a single flattened bank of sawdust and wood chips with her saliva and sticks it on the tunnel wall in a tightly wound spiral until it closes and forms a concave partition which becomes very hard when it dries. This partition is usually four spiral-layers deep. The convex side—toward the egg chamber—has a rough surface, while the concave side is very smooth.

While tunneling is sometimes

done in horizontal beams or posts, normally it is done in wood where the grain is perpendicular to the ground. In such vertical posts or limbs, the smooth concavity provides the floor for the next loaf of food and another egg. Normally, one female constructs six to eight of these chambers and fills each with food and an egg. The spiral of the mason work can easily be seen from the rough side but it is almost invisible on the smooth side.

The passages and chambers are completed and the eggs laid by early July. Whitish grubs, which hatch from the eggs, feed upon the bee's bread and in a few weeks it is consumed. The larva then enters a pupal state. Late in summer the final metamorphosis takes place and the bee emerges from its pupal skin as a fully developed carpenter bee. Though a juvenile, it is nonetheless quite as large and powerful as an adult.

Gnawing to Freedom

The young bees quickly set to work gnawing on the rough convex surface of the partition blocking their passage to the entrance. The roughness of this surface affords them a good grip, while the smoothness of the rear partition and its concavity prevents their attacking that wall by error in the event they had become turned around as larvae. In short order the juvenile bee has gnawed his way to freedom.

Unlike emerging bumblebees, the carpenter bee makes no attempt to pair off and breed immediately. The

An end view of a severed post shows the entry passage of a carpenter bee's tunnel, with another tunnel paralleling the first.

male bumblebee, of course, dies in the fall soon after fertilizing a female. The female bumblebee then finds a protected spot to hibernate throughout the winter and emerges in spring ready to lay the fertile eggs within her.

The carpenter bees, however, show no such inclination to immediately pair off when they emerge as adults. The males live nearly as long as the females. While they tend to be somewhat quarrelsome among themselves, there is still a grouping together and some traces of an organized social life which lasts until the following spring.

As the fall weather becomes colder, they increasingly remain in the tunnels—often in the very tunnel in which they hatched. It is not at all unusual for as many as 15 to 20 carpenter bees to huddle together through the winter in a single tunnel.

There is no sex discrimination between the bees as juveniles. While some remain behind to chew away and discard the last vestiges of the partitions, others go out to seek nectar to bring back for the benefit of all in the community. Some entomologists believe this pollen is necessary to build up reserves of fat in the bees to carry them through their long winter sleep.

A New Life Cycle

When they emerge from their burrows in the spring, the females fly to feed, breed, and then select a good example of wood into which to burrow and begin again the life

A cross-section of an elm post shows part of a bee's longitudinal tunneling and the cross-grain entry tunnel.

(Photos by Allan W. Eckert)

cycle. Occasionally a female will return to the tunnel she built the first season, spruce it up a bit and use it again for a second brood.

While most interesting to watch, especially when engaged in gnawing through wood, the bees are reasonably quick to anger and the observer should be careful not to alarm them. The sting—usually directed at the face—is powerful and extremely painful. It causes a long-lasting swelling that remains tender for many days.

The habits of carpenter bees make enemies among farmers, builders, and lumbermen. There is no doubt that the wood excavated by these bees becomes weakened. Instances of barns and porches collapsing have been laid directly to weakened timbers and pillars hollowed out by carpenter bees. They will even chew through painted wood.

Although *Xylocopa* is the only genus of carpenter bee, it is generally distributed throughout the United States. There are eight species in the South and West, but the most familiar species is *virginica*, with a range covering much of the area east of the Rocky Mountains but principally east of the Mississippi River and north of the Mason-Dixon line.

'MISSILES' HELP ONE-CELLED ANIMALS FEED

AN INTERESTING APPLICATION of certain principles of missile firing can be observed in the feeding habits of certain simple animals. "Missiles" with fuzzy, pointed tips were found by Dr. Maria Rudzinska of the Rockefeller Institute to play an important part in the feeding of a group of one-celled animals called Suctoria.

Under the electron microscope one species, **Tokophyra infusionum**, showed that the submicroscopic missilelike bodies in the animals' tentacles are decisive in capturing prey and making it edible.

The missile travels through the tentacle until it reaches the knoblike tip. However, some missiles are always present at the tip, even when no feeding takes place, as if ready to catch prey, Dr. Rudzinska observed.

The pointed tip of the missilelike body is covered by a sticky material which catch the animal's dinner.

Shortly after attachment, the prey is paralyzed and a stream of cytoplasmic granules flows from the prey into the **Tokophyra**. These changes and events follow in remarkably rapid succession and are probably caused by some potent enzymes. Since the missile structure is fairly complicated, it may contain an assortment of enzymes. One may be a toxic substance that paralyzes the prey, a second enzyme may cause the tentacle to broaden, while another may change the thickness of the prey's cytoplasm, thus making it flow from prey to predator.

It is still not known for sure, Dr. Rudzinska said, whether the missilelike bodies are ejected from the tip of the tentacle, or whether they simply sit stationary at the tip and are used up in succession.

Are we drinking too much milk?

"I believe I am serving my patients well in advising them to avoid milk and its derivatives."

by Walter W. Sackett, Jr., M. D.

For generations, milk has been considered the elixir of life. A Florida doctor now challenges the superiority of milk as nature's most perfect food. Dr. Walter W. Sackett points to suggested links between our high-fat diet and the skyrocketing incidence of heart attacks and strokes. He also offers a special diet for infants. The views he expresses are presented here as one man's opinion in an area where there is no certain knowledge. For opposing views, see box on page 23.

WHENEVER a person in good health asks my advice on extending his life expectancy, I have a recommendation ready:

"Stop drinking milk. And cut down on butter, cheese, ice cream, and other milk derivatives."

An incredulous "Are you serious, Doctor?" is the usual response when the questioner is not one of my regular patients. I then explain that I couldn't be more serious. I'm convinced that the drinking of milk is one of modern man's many activities that is simply being overdone. *(Continued on page 21)*

DR. SACKETT'S SUGGESTED SIX-HOUR FEEDING SCHEDULE

Feeding at 6-12-6-12 (or 7-1-7-1, etc.): Offer water between feedings but nothing between midnight and 6:00 a.m.

At 2-3 days: Cereal at 6 a.m. and 6 p.m. (12 noon-12 midnight in hospital). Thick as putty. Oatmeal, barley suggested as starters.

At 10 days: Strained vegetables at 12 noon. (Peas, beans, carrots suggested as starters.)

At 14 days: Strained meats (either at noon or 6 p.m.).

At 17 days: Soups; meat-vegetable combinations.

Midnight Feeding: May be dropped at any time. Then aim toward feeding:

Breakfast	7-9
Lunch	12-2
Dinner	5-7

At Weekly Intervals Add:

3 weeks: Orange juice and water, equal parts of each, at breakfast time, preceding cereal. Other juices later.

4 weeks: Concentrated cod liver oil—2 drops a day to start—increase 1 drop a month up to 5 drops daily.

5 weeks: Egg (soft-scrambled, coddled, or hard-boiled egg yolk).

6 weeks: Strained fruits at 6 p.m.

7 weeks: Mashed banana—very ripe.

8 weeks: Custard, puddings.

9 weeks: Crisp bacon (well crumbled).

Suggested Formula:

Evap. Milk	2	7	10	9	13*
Water	3	11	14	12	19

↓ Going home formula

↓ Hospital formula

↓ For cereal where nursing

All new foods are started at one teaspoon and subsequently increased rapidly. Fill the baby at each feeding. Do not make more than one change daily; i.e., new foods or change in formula. Unless otherwise instructed, start meals with solid foods.

* This actually represents 1 large can of evaporated milk poured into a quart container, which is then filled with water.

(Continued from page 19)

Milk is a valuable food, make no mistake about that. It contains a great many, but by no means all, of the nutrients we need; and mother's milk is the ideal food for babies. I'll even accept the familiar slogan about milk being "the world's most perfect food," if you'll let me add the words *for infants*. Milk contains large quantities of fats and calcium, both essential for the tremendous growth of an infant in the first year, but for which I can find no demonstrable need after a child has learned to subsist on other food.

Just look at the pattern of nature. Nature equips every form of mammalian life, from the tiny mouse to the ponderous elephant, with the apparatus to nurse its young—including man. With the exception of modern man and the animals he has domesticated, all mammals abandon milk as a food as soon as they can exist on other forms of nourishment. Man alone defies the natural pattern by drinking milk of another species of mammal and imposing the same custom on pets and farm animals.

Anyone who ever studied high school biology knows that nature worked out the detailed patterns of life long before mankind learned to read, write, or train doctors. Fish, birds, and the land mammals are each adapted to their own environment; and only the efficient types of life have survived. In nature's plan, it is clear that human infants were meant to have human milk, while cow's milk was intended for calves.

The digestive system of a calf, born with four stomachs, is quite unlike that of a human baby. The milk produced by these two species of mammals differs in several ways. Dr. Paul Gyorgy, emeritus professor of pediatrics at the University of Pennsylvania School of Medicine, has devoted much of his life to studying the relative values of these two kinds of milk, concluding that "for the human infant, cow's milk remains a substitute food."

Nature intended the cow to feed her calf by breast for a limited time, until the calf is able to find complete nourishment in grasses and foliage. The cow then stops lactating unless continued milk production is stimulated for commercial reasons. I believe that the human baby was intended to follow this same pattern, to use milk as a bridge until it can obtain sustenance from other foods. Continued milk drinking after weaning is, to my mind, an artificial form of nutrition. It adds nothing to human welfare when other foods are available and is harmful in the long run. Accordingly, I recommend that breast-feeding mothers never offer

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Dr. Walter W. Sackett, Jr. has been in the family practice of medicine and surgery in Miami, Fla., since 1941; has served as president of his county medical society; is currently a trustee of the University of Miami and a national officer of the American Academy of General Practice. His book, *Bringing Up Babies*, published by Harper & Row in 1962, includes his views on milk.

cow's milk to their children, instead adopting the European custom of introducing weak coffee and tea, in addition to water and fruit juices, of course, as the child is gradually weaned. Many mothers under my care have done just that with entirely satisfactory results.

My thoughts on milk began taking shape soon after I entered medical practice more than 20 years ago. They were based primarily on the observation that it isn't any more natural for humans to drink cow's milk than for a dog to nurse a lion cub. At the same time, I was observing that the arrival of the first child would often sow the seeds of discontent between a previously happy husband and wife, primarily because the infant was getting entirely too much attention. In 1949, after several years of study, I instituted a regime whereby a newborn infant is fed only four times daily (every six hours) from birth, gets his introduction to solid foods within the first weeks of life, and drops the evening feeding at three weeks to go on a three-meals-a-day schedule like the rest of the family.

Motivated primarily by the desire to make life easier and more pleasant for new mothers and fathers, yet convinced that the infant would be getting all the nourishment it needed, I was totally unprepared for the reaction. "Doctor, ours is the best-behaved baby in the world" was a remark I began hearing quite regularly. Babies fed a varied diet at greater intervals and largely left alone between feedings and diaper changes became happy and well-adjusted members of the family. At first offered on an optional basis, this feeding schedule is now standard for babies under my care. It has been used with more than 1,500 children.

From the beginning, if a mother decides not to nurse her baby, I advise her to use milk sparingly. By the time a child is two months old, it is getting three, eight-ounce bottles per day, rather than the customary four. In addition, I recommend as maximum milk strength the full-can-full-quart formula, providing a mixture only 89 per cent the strength of whole milk. Assuming that whole milk contains five percent fat, which is about average, this gives a child on this regime a daily intake of 1.25 ounces of butterfat, compared to 1.6 ounces of fat for a baby drinking 32 ounces of whole milk each day.

This may not seem like much, but a reduction of fat intake by .35 ounce each day has a significant cumulative effect. It amounts to the elimination of approximately 12.6 grams of fat from the diet each day, and at the end of a year amounts to 4.6 kilograms, or more that ten pounds of solid fat. After the first year, if mothers follow my advice and withdraw milk from the diet entirely, or compromise by using a reconstituted nonfat dry milk (fat content less than one-tenth of one percent, usually) the difference in dietary fat becomes greater, amounting to some 30

(Continued on page 24)

The Other Side of the Story

Not all medical authorities and nutritionists agree with Dr. Sackett.

The American Medical Association calls Dr. Sackett's attitude toward milk "the extreme views of one man, not supported by scientific evidence."

Milk and other dairy products should be eliminated from the American diet, Dr. Sackett claims, principally because of their high animal-fat content.

Speaking for the American Medical Association, Dr. John Youmans, former Director of Scientific Activities, says, "This does not represent sound thinking. By far the big majority of experts in nutrition still maintain that milk is an excellent all-around food."

Certain scientists and doctors, Dr. Youmans says, hold that excess animal fats may be related to disease of hardening of the arteries. Some physicians, he adds, even though not extremists in their attitudes toward animal fats, sometimes put their patients on low-animal, high-vegetable fat diets, just to be on the safe side. But at present it is by no means definitely known whether changes in diet can help prevent heart attacks. Major medical research projects are now under way to seek an answer.

Other authorities say there is apparently no correlation between the consumption of dairy products and atherosclerosis or hardening of the arteries caused by a silting up of the arteries with fat deposits. According to the Director of the Denver Child Research Council, Dr. Robert W. McCammon, fat deposits even appear in the arteries of infants. This finding suggests that this type of heart disease in adults is merely an extension of the condition that exists in the arteries of children.

If levels of cholesterol (a constituent of animal fats), dietary fat, and changes in the arteries were related, Dr. McCammon feels, this relationship should be apparent in children. After examining a large group of children, up to ten years of age, Dr. McCammon found that "cholesterol levels and fat intake as related to total fat, fat per kilogram, and the percentage of calories from fat are no higher than they are for calories of protein or carbohydrate."

From his study, Dr. McCammon concludes, ". . . Correlations in all instances are so low . . . that the only reasonable conclusion is that no simple cause-and-effect relationship exists."

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pounds per year, and more than 500 pounds by the 18th birthday.

This reduction is beneficial since all of us, including children, get animal fats in meat dishes, canned soups, desserts, and pastries, as well as in dairy products. Along with other physicians, I have been convinced for many years that there is entirely too much animal fat in the American diet.

It is gratifying to note that modern medical research is justifying this position. Heart and artery diseases, in particular, are currently associated with excess consumption of animal fats.

Americans currently eat more fats than ever before in history. More than half of us are overweight. One in five is grossly obese. As automobiles and labor-saving machinery decrease our need for energy foods, we should be eating smaller amounts of fats, but we are eating more. Department of Agriculture figures show that more than 40 percent of our calories are obtained from fats, compared to 30 percent just before World War I. In the days of the Pilgrims, whose diet included few meats and no dairy products at all (the dairy cow was not imported for over a century) the percentage of calories obtained from fats was probably 20 percent or less. These hardy people lived primarily on vegetables, fish, fruits and game.

There is confirmation of the current 40 percent figure. In U. S. Army training camps, soldiers consume about 4,200 calories a day. Of these, 42.4 percent come from fats, according to one study by military physicians alarmed by the incidence of heart disease in the armed services. Dr. Frederic J. Stare of Harvard University found that graduate students on the campus, with an average age of 24, averaged 2,900 calories daily, with 41 percent of them consumed as fats.

I shall not attempt to review here the voluminous evidence currently linking our high-fat diet to the skyrocketing incidence of heart attacks and strokes. Fats in the diet are not the only factor under suspicion as causes of heart disease, of course. The amount of exercise we get is important, and most of us don't get enough. The stress to which we are subjected seems to play an important part. Perhaps most important, some of us inherit a susceptibility to heart and artery diseases while others inherit a resistance. But even with an inherited resistance, it makes sense to watch the diet. During a recent symposium, Dr. Donald S. Frederickson of the U. S. Public Health Service noted that genetic influences are not independent of dietary habits and may be modified for good or ill by the amounts and types of fats in the diet.

Some fat in the diet is necessary. The late Dr. Norman Jolliffe of the New York City Health Department's Bureau of Nutrition, recommended that no more than 30 percent of our calories should be consumed as fats. A large proportion of these should be the "unsaturated" fats of fish and vegetable origin, as

distinguished from the "saturated" fats of animal origin, including dairy fats.

If Dr. Jolliffe's advice is worth following, and most physicans currently believe that it is, I see no reason for waiting until middle age before doing so. The build-up of fatty deposits in the arteries is a slow process that begins early in life. The arteries of ten-year-old American boys show its effects. From a heart disease standpoint, it makes a great deal of sense to start watching dietary fats in the beginning. As soon as the first year's great growth is completed, I can see no need for heavy fat intake. One of the easiest ways to reduce it is to stop drinking milk and eating dairy products.

Even pregnant mothers do not need milk, I have found. Mothers-to-be under my care are advised to follow the low-fat diet, without milk. I have seen no adverse effects on their offspring. On the contrary, I believe the infant is better off if it obtains less fat from its mother. Meanwhile I have observed a signifiant value of this regime. Mothers consuming less fat have a much lower tendency toward the nausea of pregnancy, known as morning sickness.

The calcium in milk may also be potentially dangerous over the long term. Needed for building strong bones and good teeth, calcium is supplied abundantly in milk. Actually, we need much less calcium after the first year. Adequate amounts can be found in many common fruits and vegetables. I have long felt that too much calcium, like too much of anything else, can be harmful.

Confirmation of this view was presented during the mid-1962 meeting of the American Medical Association by Dr. Hans Selye, the famous Canadian researcher who pointed an accusing finger toward stress as a causative factor in heart disease some years ago. In laboratory animals, Dr. Selye was able to produce premature signs of old age, wrinkled skin, falling hair, impaired eyesight, and hardening of the arteries, by feeding large amounts of calcium. He was able to reverse this accelerated aging process by removing calcium from the diet again. While his work is still experimental, it indicates that there may indeed be dangers in a lifelong intake of calcium greater than the body's needs.

Milk falls short of the "perfect food" class in another sense, as well. It is deficient in Vitamin C, so that virtually all physicians advise the feeding of orange juice or a Vitamin C preparation to infants at an early age. It is also lacking in iron, so that a common problem among babies is an iron deficiency anemia as rapid growth places additional demands upon the iron supply the baby had at birth. However, I do not see this problem in the babies who are introduced to strained solid foods early in life.

There are, in short, a great many questions about milk that require answers.

Do your brain molecules change their shape when you think?

As you read this sentence, what is happening to your brain?

What physical and chemical changes are taking place that enable you to grasp meaning from what you perceive?

Dr. Leroy G. Augenstein, chairman of the Department of Biophysics at Michigan State University, is doing research based on a theory that man receives, stores, and uses information in much the same way computers do. In the brain, molecules replace transistors and other electronic gear.

These molecules, by changing their shape in a sort of "flip-flop" fashion, enable humans to think in a series of rapid-fire, yes-no decisions, according to the scientist's theory. He estimates that they ordinarily make 20 to 25 such decisions (bits) per second but are capable of as many as 30.

"The theory is crude, and it may be wrong," Dr. Augenstein comments, "but I think it offers a reasonable basis for conducting experiments that will lead to more knowledge."

A better understanding of the molecular basis for the thought process, he believes, could revolutionize education and the treatment of mental illness. It might even make it possible to bypass the senses and place knowledge directly in the brain, he contends.

Dr. Augenstein arrived at his theory by two paths, by experimenting with decision making and by studying the shape of brain molecules.

Several years ago, Dr. Augenstein was a member of a group at the University of Illinois doing research to help the Department of Defense make better use of men and computers in tracking aircraft flights.

In one experiment, the group found that subjects could identify and play musical notes at the rate of four or five per second when the notes were selected at random from a 32-note keyboard.

The researcher reasoned that the subjects mentally divided the 32 notes into two groups of 16 each and classified the note to be identified as a member of one of them. Narrowing the selection down to eight, then to four, then two and

finally to one note by this halving process would require a total of five decisions. Since the subjects identified four or five per second, it appeared that they might have been performing at the rate of 20 to 25 bits per second.

While this might seem slow, Dr. Augenstein points out that at the rate of 25 bits per second, it would be theoretically possible to identify one of 33 million musical notes per second by this yes-no binary process. On the other hand, some computers which operate on a binary process handle up to a million bits per second.

Since his work with the Illinois group, Dr. Augenstein has been doing research on the shapes of biological molecules. Now he hopes to combine his knowledge of molecular structure with what he knows on the subject of perception and thinking.

Michigan scientists theorize that the eye relays information to the brain in bursts. Each burst lasts about 33 milliseconds (33/1,000ths of a second), and relays a large amount of information about the outside environment to the brain. Between successive bursts there is an interval of about 250 milliseconds. During this interval, the information is stored where it is temporarily available for processing by the brain's molecular "computer." This accounts for an individual's ability to recall many things about something he views for only a small fraction of a second.

Dr. Augenstein wants to test the idea that large molecules in the brain process the temporarily stored information by changing the conformation, probably by "flipping" or "flopping" from one or two basic shapes.

EVEN INSECTS HAD SOULS AMERICAN INDIANS BELIEVED

Every insect has a soul, and spiritually the bees and the wasps are the most powerful. So the American Indians believed, according to Stephen W. Hitchcock of the Connecticut Agricultural Experiment Station.

One tribe thought the ant and the yellow jacket wanted people to die because these insects are gravediggers. These same Indians poisoned their arrows with a concoction of yellow jacket's nest boiled with wood from a tree that had been struck by lightning.

In the far North, where mosquitoes were the most common insect, the Nahane tribe explained the origin of the pest thus: Two brothers were about to be eaten by a giant. They outwitted the giant, then broke open his head. It was definitely a mistake, Dr. Hitchcock says, "because mosquitoes flew out, and we have had them ever since."

In eastern Canada, the Montagnais believed that each type of animal had a spiritual overlord. A tabanid fly was the overlord of fish, particularly salmon and cod. This fly appeared whenever fish were taken from the water and occasionally bit the fisherman to remind

Dr. Wallace Gobetz, director of the Testing and Advisement Center at New York University, administers the number concepts test, Stanford-Binet Intelligence Scale. (I.Q. test).

him that the fish were in its custody and to warn against wastefulness.

The Ojibway considered the butterfly a symbol of childish play and used a butterfly design on children's toys. Children were taught not to kill the butterflies, but to invite them to join in games.

Dr. Hitchcock points out that the importance of insects, for the Indians, was more spiritual than material. Insects were considered as a part of the natural world, not as pests, and demanded no special interest. In fact, the eastern Ojibway believed that insects acted much the same as men do when together. If, for example, a cricket found food, it would invite its companions. If the cricket were killed, then a messenger would warn the rest, and they would come and eat all that could be found worth eating, and in this way inflict punishment upon men.

BIG FAMILIES FOR LOW IQ COUPLES DOESN'T HURT INTELLIGENCE LEVEL

Why doesn't the general intelligence level decline, when it is parents with very low I.Qs. who tend to have the biggest families? This seeming paradox has puzzled scientists for years. Recently, a team of geneticists believes, an explanation has been found.

According to the scientists, while couples with very low I.Qs. tend to have the biggest families, people with low I.Qs. are less apt to marry than other people. This averages out the number of children produced by the very low I.Q. group and puts it in balance with the rest of the population.

"As a result," the geneticists conclude, "the mean I.Q. of the population should remain relatively static from one generation to the next, or at least should not drop rapidly.

Hopefully, it might rise slightly."

The researchers drew their conclusions after analyzing the I.Qs. of parents and children from 1,016 families, in the largest study of its kind to date.

The study showed that the size of the family was sharply larger when the parents' I.Qs. averaged below 70—a segment of the population that might be considered mentally retarded.

But 97 to 100 percent of the adults in other I.Q. brackets were married, whereas the marriage rate was only 37.93 percent among mature persons with I.Qs. of 55 and below and 86.48 percent among those with I.Qs. of 56-70.

The study also showed that the average intelligence of children in a family tended to drop sharply in families with more than five children.

The geneticists found I.Q. levels tending to revert to the mean. In low I.Q. families, the children's I.Qs. tended to be higher than those of their parents' and to reach up toward the mean. In families where the parents had high I.Qs., the children tended to dip down toward the mean.

The study was conducted by Dr. James V. Higgins of Michigan State University and Drs. Elizabeth W. Reed and S. C. Reed of the Dight Institute for Human Genetics.

The letters IQ stand for Intelligence Quotient. This number is obtained by dividing the mental age by chronological age and multiplying the result by 100. It is the mental age that IQ tests supposedly measure:

$$\frac{\text{(Mental age, as determined by IQ test)}}{\text{(Chronological age, the average score made by children of the same age as the one whose IQ is being computed)}} \times 100 = \text{Individual IQ}$$

Although what is considered a normal distribution of IQ scores differs among different psychologists, the following listing can be used as a rough guide:

IQ	Classification
130 or more	Very superior
115 to 129	Superior
85 to 114	Normal or average
70 to 84	Dull
69 or less	Mentally defective

Key to health:

Dr. Roger J. Williams is Professor of Chemistry and Director of the Clayton Foundation of the Biochemical Institute of the University of Texas. He is the discoverer of pantothenic acid and a key B vitamin, a pioneer with folic acid, an anti-anemia vitamin. The recipient of the Mead Johnson award of The American Institute of Nutrition, he is a member of the National Academy of Sciences and past-president of the American Chemical Society.

In an interview with author and teacher Flora Rheta Schreiber, Dr. Williams explores what he calls the "genetotrophic" approach to understanding human behavior and disease—that is that all people are different and have different

needs. Understanding your innate uniqueness, Dr. Williams believes, is the key to mental and physical health. He says we each have an inborn, individual capacity to resist disease and a distinctive pattern of mental capabilities, and we must learn to work with these differences.

DR. WILLIAMS' OBSERVATIONS:

On emotions: "While bodily states are influenced by mental states, it is even more easily demonstrable that one's body chemistry greatly influences mental and emotional states. Body chemistry has tremendous implications for psychiatry."

On illness: "When we are ill, we require different treat-

your heredity

ment. Yet though few physicians would argue with this general idea, they are all too likely to treat patients in a routine fashion."

On heredity: "By neglecting heredity factors, as we have done in the past decades, we fail to put in proper perspective the individual differences that are at the root of all personality development."

On Freud: "I reject Freudianism's assumption that we are all alike at the beginning of life."

On disease: "We are of the opinion that many diseases will remain mysterious until individual differences in body chemistry are further explored."

How People differ: Q and A

Dr. Williams, from your work as a biochemist you have developed what you call the genetotrophic approach to understanding human behavior and disease. What is the genetotrophic principle?

As applied to human beings, it is simply that individuals have quantitatively different nutritional requirements. Many diseases arise in specific individuals due to unusual nutritional needs and the failure to meet them. I believe that human beings and their problems should be studied not from any restricted point of view but from all angles, including the biochemical and the physiological. Up to now, we have tried to understand human behavior as though persons were assembly-line products of mass production. Each person has profound built-in differences.

Are you saying that individual differences, rather than similarities, are the key to understanding people?

I would say they are a key and largely an unused one, but similarities are important too.

Has science penetrated the problems of individual differences?

Science has been traditionally preoccupied with similarity. It wasn't until 1950 that the first atlas of anatomy, giving substantial information about widespread variation, was published. Barry Anson, Professor of Anatomy, Northwestern Medical School, has told me that in his researches he discovered that some so-called anatomical facts are not facts at all. Handed down in textbooks from one generation to another, some of these so-called facts do not apply to more than 15 percent of the population.

How do human beings manifest their biochemical individuality?

We show distinctive patterns in our endrocrine glands, our sense of taste, smell, our equilibrium sense, our reactions to temperature, our blood chemistry, our urinary excretion patterns, the enzyme levels of blood and our hormonal patterns resulting from anatomical variations in the endocrine glands.

Since hormones influence the direction and intensity of metabolism, their effects are superimposed upon others to increase interindividual variation.

There are also great individual differences in hearts and circulatory systems, in the pattern of blood vessels, in the size and shape of so-called normal stomachs, livers, intestines and the relative positions they occupy. Moreover, physiological and biochemical variations with respect to alimentation may be superimposed upon anatomical differences. It is therefore not surprising that people vary widely in their patterns of eating and elimination.

The brain and the nervous system also show infinite variations. Differences in brain function are related in a very complex way to variations in brain anatomy, and the chemical processes incident to different enzyme deficiencies and variations in blood supply. These variations contribute to differences in mental capacities (in a wide variety of different directions), for talents and aptitudes. Einstein, for instance, had a marvelous brain for mathematics and physics, but a mediocre one for language. This illustrates Guilford's observation that there are many facets to everyone's mind and correspondingly many ways in which brains can be unusual.

Nervous systems are highly individual, too. We see this individuality when we observe that one person's sciatic nerve is so exposed anatomically as to make injury likely, while another's is so well protected as to make injury virtually impossible. We see the shaping hand of individuality, too, in the way nerve endings work and account for highly diverse reactions to heat and cold and to pain. The reactions to pain run the gamut from hypersensitivity to the inability to feel any pain at all no matter what the illness or injury. Though the extremes are not common, they do exist and might cause us to excuse the weeper because he can't help it and deprecate the brave because he is insensitive. There are, however, too many complications to make possible such clear-cut value judgments.

Someday it will be possible to appraise the effect that differences of nerve endings and their dissimilar distribution in different persons have in creating distinctive sensory responses and differing mental attitudes. Meantime we know that nerve patterns vary substantially from person to person and that nerve conduction varies in speed in different nerves and in different individuals. This recognition should point the way to progress in human understanding.

Since all nerve activities are chemical in nature, they are influenced by metabolism in other parts of the body. While bodily states are influenced by mental states, it is even more easily demonstrable that one's body chemistry greatly influences mental and emotional states. Body chemistry has tremendous implications for psychiatry.

By stressing the differences among human beings, you are challenging, are you not, the very concept of normality?

An individual who is thoroughly "normal" in a textbook sense, would be a most unusual person. For, while the concept of normality is perfectly valid when applied to one parameter like height, weight, size of heart or brain, cholesterol level of the blood, etc., it has no validity when dozens of parameters are involved simultaneously. A person who is "normal" in one respect is likely to be out of line in other respects, since in every human being there are hundreds of measurable parameters and nobody is likely to be "normal" in all of them.

What are the practical implications of these variations in body chemistry?

They mean that since everybody is different, we all have different nutritional needs, have different reactions to drugs and different kinds of susceptibility to illness. When we are ill, we require different treatment. Yet, though few physicians would argue with this general idea, they are all too likely to treat patients in a routine fashion. Their training, which was centered on "normal" man, has given them too little knowledge of the significance of the numerous anatomical, biochemical, physiological and psychological peculiarities which each of us possesses.

The same tradition that has stressed similarity has also placed environment ahead of heredity as a dominant factor in determining human behavior. What, in your view, is the weakness of the traditional emphasis?

It lacks insight. For environment can not exert its effect independently of heredity. What heredity has done for any given person is the key to the successful environmental treatment of him as an individual. For instance, we do not sell spectacles

to "man" in carload lots. Rather, do we first find out whether he needs glasses. It is largely heredity that has endowed him with this need. Only by ascertaining the need are we in a position to prescribe the glasses, which represent a suitable environmental adjustment.

Every biologically trained person knows that heredity and environment work together and cannot be divorced. Yet the sentiment is widespread that "we can't change our grandparents, so we must see what we can do environmentally." The truth is, however, that, though we must improve the environment so that it yields maximum good, we are often in the dark as to what to do environmentally until we know what heredity has done. Yet ignore it we do in areas even as crucial as mental health. "In most of the present day books on psychiatry," says Dr. Walter C. Alvarez, the famous Mayo physician, "there is not even a short section on heredity. The book resembles a text on paleontology written for a fundamentalist college, with not one word on evolution."

Your emphasis on differences rather than similarities of people, on the uniqueness of each of us, on the genetotrophic principle for interpreting human behavior, constitutes a new approach to human nature. Much of this approach is based, is it not, on biochemical individuality?

Yes, and biochemistry is the area of my special training and experience.

What concrete evidence is there to justify your position with regard to biochemical individuality?

Individuality is the cornerstone of evolution. Every biologist believes in individuality because, without it, evolution could not have taken place. For example, if all the offspring of a given union were identical, then there never could be any change. Even the lowliest creatures exhibit individuality in its most primitive form. The higher we rise in the evolutionary scale, the more pronounced becomes this individuality. In human beings the diversity is, of course, greatest of all. Variation and individuality must enter into every comprehensive study of human beings and their problems.

What is the relation of this new approach to human nature to

the understanding of human personality? For instance, by emphasizing innate individual differences and their hereditary basis, are we excluding the dynamic aspects of personality development?

Personalities are not static. They grow and develop and are moulded during childhood. No one denies this. I am simply saying that they don't start out with a blank slate. Rather do they develop the individuality with which they have been endowed by heredity. The recognition of the role heredity plays by no means rules out the importance of conditioning. By neglecting heredity factors, however, as we have done in the past decades, we fail to put in proper perspective the individual differences at the root of all personality development.

Can we speak of a "biochemical personality"?

Yes. Moreover, this personality must be taken into consideration when we try to interpret the increasing number of personality disorders and difficulties in our time.

Does the emphasis on the individuality of the biochemical personality repudiate Freudianism?

There may be things in Freudianism which I might accept. Its assumption, though, that we are alike at the beginning of life, I reject. I also reject the behavioristic psychology which pictures the development of personality merely as a pyramiding conditioning process whereby a "blank-page" infant is continuously modified in his responses by the stimuli he receives.

What should be the aim of the biochemical approach to personality?

It should explain what personality is, how it originates and how it can be modified or improved. The biochemical approach should be coordinated with the anatomical, physiological and psychological approaches.

What meaning do these facts of individuality have for learning, for aptitudes and talents?

They mean that not everybody can be a competent rope walker

or violinist or watchmaker. Common sense and realism dictate that we observe the plain truth that each human being has a distinctive pattern of abilities that, according to twin studies, has inheritance as its basis. There are great differences in the pattern of inborn mental capabilities. Some persons are born with very eccentric patterns while others have relatively even patterns without strong contrasts. Thurstone, at Chicago, made clear that these patterns, which are solidly based in anatomy, physiology and biochemistry, are very individual.

What are the individual differences in the capacity to resist disease?

They are enormous. We do not yet know, however, how to spot prone individuals. Expertness in this area has not developed. We have to look at individuals.

How do the facts and ideas about individual differences in body chemistry apply to the treatment of disease?

We are of the opinion that many diseases will remain mysterious until individual differences in body chemistry are further explored. It is not man who suffers from arthritis, becomes obese, grows bald, suffers allergies, succumbs to multiple sclerosis and becomes mentally deranged. Instead, these things happen only to certain individuals who have peculiarities in their make-up, which predispose them to these diseases.

Are there important individual differences in the way we are affected by alcohol?

Yes. Jetter studied 1,000 persons who had been arrested or investigated because of drunken driving problems. Using objective tests, he found that a few were "intoxicated" when the level of alcohol in the blood was as low as 0.05 percent. At the other extreme and by the same tests there was soberness when the level of alcohol in the blood was eight times as high —that is, 0.4 percent. In courts very often 0.15 percent is taken as evidence of drunkeness.

You have studied alcoholics in your own laboratory. How did you apply the concept of biochemical individuality in this study?

Actually the genetotrophic concept grew out of our work on alcoholism. We became convinced about fifteen years ago that only certain individuals lean toward alcoholism and that individual differences in body chemistry must be at the root of the problem.

What is an alcoholic?

One who yields to uncontrolled drinking and, after the first drink, craves more and more. Incapacity for daily living and activities generally results.

Is this insatiable craving always linked to emotional problems?

No. Alcoholism exists in some persons who have had happy childhoods, happy home lives and who are not frustrated. Conversely, some people who have had unhappy childhoods and frustrated lives have no inclination toward alcoholism.

Have you found a basic reason why certain persons are alcoholism-prone?

I believe we have. By inheritance these persons have an unusually high demand for certain nutritional elements. When they violate the laws of good nutrition and drink alcohol in quantity, they crowd out of their diet the minerals, amino acids and vitamins. They are so constituted that they cannot do this and remain well. They become nutritionally deficient. The deficiency causes nervous tissues to become deficient and get out of whack and makes them easily poisoned by alcohol. This in turn stimulates alcohol craving. Alcohol consumption causes further deficiency and poisoning and the individual is then in a vicious cycle.

Are there persons who are not alcohol-prone and will not be, irrespective of the circumstances of their lives?

Yes, there are such persons. Some may turn to dope rather than to alcohol. But many take what comes without resorting to any such measures.

Are there persons who drink heavily and still run little danger of becoming alcoholics?

People who are not alcoholism-prone can drink alcohol heavily for years and years without losing control because their body chemistries are different, their needs for the crucial nutritional substances are low, and deficiencies do not develop. Persons who are in stressful situations may have their alcoholic craving increased because their nutritional needs for particular items are augmented. They may or may not actually become alcoholics.

Does a person who is intoxicated by a little alcohol show alcoholism-proneness? In other words, is he more likely to become an alcoholic than the person who drinks larger quantities before he is intoxicated?

I doubt if this has much significance but we really do not know. Individuals haven't been studied enough.

What technique do you use for overcoming the problems of alcoholics?

If they want to overcome their difficulties we urge them to eat wisely—plenty of the kinds of foods that yield amino acids, vitamins and minerals—and take nutritional supplements to supply their accumulated deficiencies, if possible.

We have put these ideas to the test and have succeeded in making it possible for many alcoholics to abstain and to be free year after year from any temptation or desire to drink. In some cases the effects have been immediate and little short of miraculous.

How can we apply your view of biochemical individuality in our daily lives?

If one is aware of his own individuality and that of others, he will seek to learn how to eat right, exercise right, drink suitably, sleep so as to promote best health. He will be tolerant and patient with others. He will know they are not built like himself. He will not expect his children to be just like him, nor like each other. He will look for and appreciate different talents. It is better to induce elation or at least well-being by proper diet and hygiene, which are fundamental, than by happiness pills and tranquilizers, which are artificial and extraneous agents that cannot be used continuously with safety.

'Underground Rain' Used in Russia To Irrigate Crops

A water-filled ditch was one of the first ways man brought water to his thirsty farmlands. Since its prehistoric beginnings, this method of irrigation has undergone many refinements. Man has made water flow through, around, and over, irrigated fields, and crops have sprung from once barren lands.

In a world where water, once a plentiful natural resource, has become a scarce commodity, this method of irrigation has one important disadvantage — it wastes water. More water than is actually necessary for plant growth is brought to the fields, then allowed to soak away.

A more efficient system of underground irrigation has been devised by Soviet scientists. With a metal tube called the hydrodrill, they inject relatively small amounts of water directly into the soil around an individual plant's root zone.

Irrigation by injection is claimed to cause water vapor present in the capillary channels and air spaces of the soil to move into and condense in the watered zone. In effect, the water added to the soil is increased by this condensation, or underground rain, and the soil is slowly and methodically moistened from within.

Russian experiments have shown that this system of internal irrigation is two or three times more efficient than traditional surface irrigation. The experiments also show that an underground shower at a depth below that of the normal penetration of surface water can dissolve mineral salts present at that level. The dissolved salts can then be used as an additional source of plant nutrients.

Mechanically, the hydrodrill resembles a giant ball-point pen. A metal tube about three feet long and 1½ inches wide, it tapers to an automatic valve at the tip. From a supply tank water travels via a hose to the drill under a pressure of 1 to 2 atmospheres. (An atmosphere is the pressure of the air at sea level, 14.7 lbs. per square inch.) In a second or two, the drill bores a hole in the soil and fills it with a jet of water to a predetermined depth.

The hydrodrill promises to have other uses in addition to subsoil irrigation. As part of a new technique known as hydromechanization, the drill could be used to sow seeds suspended in a solution of fertilizer. It could also be used to shoot pesticicides and weed killers into the soil at the base of the plant. The design of a machine to sow maize by hydraulic methods is being readied by Soviet agricultural scientists. The story of the hydrodrill was reported in *The New Scientist*.

ACUTE DISEASES IN ALASKA NOW PRESENT THE YEAR ROUND

Since its discovery in 1741 by the Dane Vitus Bering, Alaska has been subjected to the influences of civilization. Unfortunately, among the benefits brought by the recently accelerated social and economic development of Alaska is a detrimental change in the disease patterns of that once-isolated area.

The former chief of the infectious disease program, Arctic Health Research Center, Anchorage, Dr. Karl R. Reinhard, calls this development a "drastic change."

"Early in the century and previously," Dr. Reinhard writes in the *Journal of the American Medical Association*, "American Arctic populations were subjected to epidemics of highly contagious diseases by the advent of visitors from more southerly regions during the late spring and summer. Smallpox, influenza, measles, and other epidemic diseases were frequently traceable to direct contact with outside populations."

During the last 40 years, however, the Arctic regions have been opened up to development of resources, new habitation, commerce, and military activities.

"In Alaska," Dr. Reinhard continued, "most of the small villages are in constant contact with the northern centers of population, and the latter exchange people constantly with the heavily populated southerly regions. Acute diseases are now a year-round experience in most communities in the Western American Arctic."

Data compiled by Dr. Reinhard showed that polio viruses, Coxsackie virus, and ECHO viruses are widely distributed in Alaska. Polio viruses, particularly Type 2, have been prevalent for a number of years.

A study of the degree of immunity to polio among Alaskan natives based on a 1953-1954 survey, showed a high level of resistance among 717 men in 47 villages of western and northern Alaska. Less than one percent had no antibodies against any of the three polio virus types. Overall, 87 percent had antibodies against Type 1, 92 percent against Type 2, and 62 percent against Type 3.

Dr. Reinhard is looking forward to more needed research to answer questions about the relationship of these viruses to human disease. It would be especially desirable to learn whether they could be responsible for an often fatal disease among infants in Alaskan villages.

Diseases with symptoms involving the central nervous system or respiratory failures are a common cause of infant deaths. An investigation of intestinal viruses might also explain the wintertime epidemics of stomach upsets among Alaskan villagers.

DIGGING IN JORDAN SUBSTANTIATES OLD TESTAMENT

The history of Shechem, one of the most strongly fortified cities of ancient Palestine, lies buried in a ten-acre mound, one and one-half miles east of the present-day city of Nablus in Jordan. When Shechem flourished in Egyptian and Biblical times, it guarded the Nablus pass between Mt. Ebal and Mt. Gerazim, making the city a center of trade and communication.

References to Shechem can be found in the Bible. Although preceded by an oral tradition that was centuries old, the Old Testament story of the Israelites first began to be written down during the 10th century B.C. It was upon the oral traditions that had been passed down from generation to generation that the first scribes relied for their history.

Mention of a holy place with an altar and a sacred oak in the city of Shechem appears in Genesis and reappears in the Old Testament from time to time up to the book of Judges. In Genesis 12, the Lord commands Abraham to go "unto the place of Shechem." There the Lord appears and promises the land to the descendants of Abraham, and there Abraham builds an altar. At nearby Mt. Ebal, Moses commanded the Israelites to build an altar and plaster stones so that the laws of the covenant could be inscribed on them. Joshua put a great stone beneath Shechem's sacred oak as a witness of the covenant. Abimelech, was proclaimed the first king of Israel "by the oak of the pillar that was in Shechem."

The Bible does not say when these events occurred, but recent excavations at Shechem provide a concrete background and approximate dates to the story. About 1900 B.C. the inhabitants of Shechem enclosed an open-air shrine within a large courtyard that had adjoining rooms for both priests and pilgrims. Around the courtyard a wall fortification was erected to bring the sacred area into the confines of the city. Around 1650 B.C. this structure was abandoned, and the largest temple-fortress in Palestine was erected over its foundations. The temple existed until 1100 B.C., but Shechem itself persisted as a city until it was destroyed about 107 B.C.

Starting with the most recent ruins and working backward in time, archaeologists from Drew University, McCormick Seminary, and Harvard University have reconstructed a portion of the temple courtyard and restored the sacred pillar mentioned in the book of Judges to the spot where it stood in front of the temple. Then the archaeologists dug below the court-

yard of the temple and found the ruins of the original open-air shrine. Although the structure had been rebuilt on many occasions, the shrine remained in the same location. Only its floor level was raised with each successive renovation. When the area was filled in for the building of the temple, the shrine's altar and sacred pillar were carefully placed on a new level but directly over their original sites.

If the interpretations of the archaeologists are correct, the altar and sacred oak at which Abraham and Jacob worshiped could have been in existence at Shechem as early as the 19th century B.C. According to Prof. G. Ernest Wright of Harvard, the major significance

The sacred area at Shechem, where Abraham and Jacob worshipped, where Joshua rallied the tribes of Israel, and where Abimelech was crowned Israel's first king (above).

The great east gate of Shechem (below). The pairs of huge stone blocks on either side once had large wooden beams between them that could be drawn closed in time of war.

of the city's sacred area is that it allows a history with dates, worked out archaeologically, to be set back-to-back with an oral tradition that predates the writing of the Bible. The achievement is similar to the light Schliemann's excavations in Asia Minor shed on the Homeric legend of Troy.

In reconstructing the history of the sacred area, the archaeologists supplemented their findings with photographs and maps made by German scientists at Shechem in the 1920s. Once presumed lost, these records were found in the basement of the Lutheran Church in Jerusalem.

The Shechem expedition was also sponsored by the American Schools for Oriental Research with assistance from the Bolligen Foundation.

SOVIETS USE CHARCOAL TO MAINTAIN LOW TEMPERATURES

Cryogenics is a branch of physics that deals with the changes matter undergoes at low temperatures. Although any degree of cold could be —strictly speaking—a low temperature, cryogenics specifically refers to the behavior of natural phenomena at temperatures below the boiling point of oxygen—below 90° Kelvin.

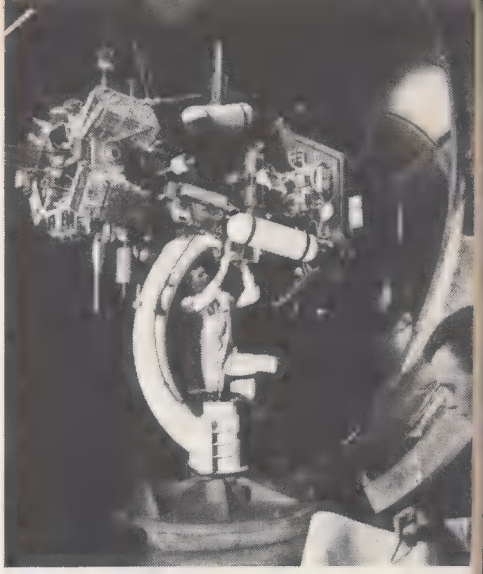
In thermometry, the science of measuring temperature, the thermodynamic scale named after William Tomson, Baron Kelvin, measures temperatures ranging upward from absolute zero. On the absolute scale, 0° K. is equivalent to —459.6° Fahrenheit or —273.2° Centigrade.

In cryogenic experimentation, low temperatures are generally created in cryostats which use escaping gas from boiling helium as the medium for their superrefrigeration. Temperatures as low as 0.7° K. above absolute zero can be obtained from escaping vapors of helium, which boils at 4.2° K.

The cold helium gas is carried to the cooling chamber by pumps. An improved method of vapor distribution has been discovered by three Soviet scientists who have added charcoal to the pumping system.

Charcoal, a black, porous form of carbon, is noted for its powers of absorption. That is, extremely thin layers of molecules of liquids, dissolved substances, and gases adhere easily to its solid surface.

As with other materials, the properties of charcoal change at cryogenic temperatures. Its adsorbing power increases as the temperature is reduced. According to the Ukranian Academy of Sciences' physicists, B. N. Esel'son, B. G. Layarev, and A. D. Shvets, several ounces of charcoal—at temperatures below 1° K.—will collect more than 908.10 quarts—or more than a thousand liters—of helium vapor per second. After maintaining this adsorption rate for an hour or more, the charcoal can be reactivated by moving it to a warmer part of the cryostat. Half an ounce of charcoal in a movable capsule was used successfully to keep temperatures in a Soviet cryostat at 0.704° K. for several 30 minute periods, the scientist said.



Technicians at the Space Technology Center in Valley Forge, Penna., test the stabilization and control system of a working model of a Nimbus weather satellite.

Advanced weather satellite ready for launching

LATER this year a buoy-shaped, 700-pound satellite identified as Nimbus, will be snapped into orbit to send to earth pictures of shifting clouds and other weather breeding formations from all over our planet. The orbiting of Nimbus will be the first step in the creation of a weather observation system, which, if successful, will probably bring more daily benefits to more people than any other space project.

A Thor Agena B rocket will launch the vehicle from the Pacific Missile Range. The aimed-for orbit of Nimbus will be 500 miles above the earth on an 80 degree tilt to the equator. Unlike its predecessor Tiros, Nimbus will be earth-oriented. That is, it will always point the same face toward the center of the earth in order to see every square foot of cloud coverage on earth, every day. As a result, Nimbus is expected to make weather forecasting by satellite a practical reality.

Each orbit will carry Nimbus through 68 minutes of sunlight and 35 minutes of earth shadow. Two packs of three television cameras each will "take" and transmit back to ground stations approximately 1,300 cloud coverage pictures each day. At night, a special infrared picture of the clouds will be taken by sensing their heat.

In orbit, Nimbus may utilize two systems to relay weather informa-

tion to ground stations. One is a method of recording the cloud cover pictures taken by the camera packs on magnetic tape. A ground command orders a playback of the tapes which are then erased. A ground station at Fairbanks, Alaska, which is in reception range during ten of the 14 orbits, will receive the pictures. Another ground station is planned for the east coast to cover all of the Nimbus orbits. The pictures taken are a three frame composite that will cover 450 miles of longitude and 1,450 miles of latitude. The other weather observation system for Nimbus is an experimental system that will transmit pictures of clouds back to earth as soon as they are taken.

The Nimbus spacecraft itself, consists of a doughnut-shaped sensory ring some five feet in diameter and a box which houses the control subsystem. These two assemblies are joined together by a set of six struts. Attached to the vehicle on a shaft that runs through the control subsystem are two rectangular solar paddles that give Nimbus the appearance of a winged navigation buoy. High pressure gas jets will orient the vehicle in orbit so that the television cameras and radiometers will always face the earth and the 5,740 solar cells on each of the paddles will always face the sun.

But before Nimbus goes to the launching pad, it will be subjected to the most torturous and extensive preflight testing ever inflicted on space vehicles before lift-off. The phototype of the vehicle, and then the actual flight vehicles themselves, will each undergo 53 days of grueling operation in the environment of space—right here on earth.

These tests will be run in the most extensive complex of industry-run outer space simulation facilities in the world, located in General Electric's sprawling Space Technology Center at Valley Forge, Pa. Here the effects of a missile launching range, a telemetry range and space itself will be duplicated in a 240-foot long building on the G-E grounds.

Balanced on a Ball

One day within the next few months, after its separate parts have been subjected to electrical checkouts, the buffeting of a rocket liftoff, and the cold space vacuum, the Nimbus will be painstakingly fitted together, its electronic innards locked into place, and an overhead crane will slowly lower it through the top opening of a 40-foot diameter steel sphere. The hatch will be sealed and for all intents and purposes, Nimbus will be 500 miles up in deep space.

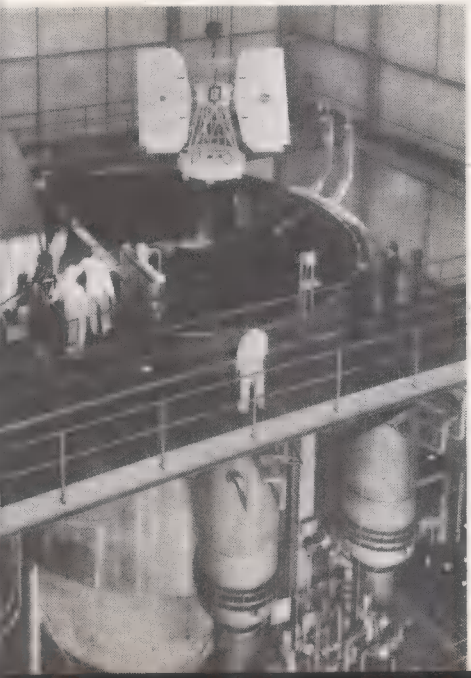
The vehicle will be balanced on a six-inch steel ball which in turn will be floated on a microscopic film of air. The balance will be so critical that it would be unbalanced by the weight of a match stick at either end—despite the fact that the vehicle, plus test equipment will weigh a ton.

The air bearing is the heart of the test chamber's three-axis simu-

lator facility which allows the Nimbus vehicle to roll, pitch, and yaw just as it would in space. Small gas jets for major position corrections and flywheels for fine adjustments directed by the Nimbus' delicate control mechanisms will bring the vehicle back to its proper position.

The control systems will read the same signals in the test chamber that they would in space from the earth, sensing the temperature differences between the earth and the surrounding cold of space. Earth and the sun will be represented in the simulator by special mechanical and electronic devices that will produce the same output signals as the sun and earth.

A 700 pound Nimbus satellite is lowered into one of the giant space simulators at the Space Technology Center. Nimbus will transmit 1300 weather pictures each day.



The vacuum in the chamber will be pumped down to equal the vacuum of space at 500 miles above the earth. Temperatures will be varied to assure that the Nimbus will operate under all the situations it will encounter during earth orbit. In fact, the conditions during the entire test cycle will be far more severe than the actual conditions in space.

During the test, pattern pictures will be fed electronically to their cameras and stored. Every 104 minutes as it would in space, the Nimbus will relay the pictures to readout devices in the simulator's control room.

During the testing cycles, batteries in the space vehicle will be periodically charged, the vehicle will be set loose on its air bearing and pushed 6, 12, 18, 24, and finally 30 degrees off position. Its controls will then seek out the earth, figure out the corrections that should be made, activate the jets and flywheels and swing the Nimbus back into proper alignment, to within one degree.

The tests will be carried out at temperatures varied to duplicate the effects Nimbus will undergo while traveling in alternating sunlight and earth shadow during its orbit of the earth. The Nimbus vehicle will be insulated in order to maintain its temperature within plus or minus ten degrees of 25° C., because electronic components function better where wide temperature variations are avoided.

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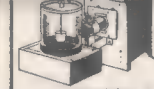

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BOOKS

Benedict A. Leerburger, Jr.
Book Review Editor

FACE OF NORTH AMERICA: The Natural History of a Continent, by Peter Farb. Harper & Row, New York City. 316 pp. ($6.50). North America is a mighty land. It has to be to stand redescription and illustration by so many and at such short intervals. With *Wild America,* Roger Tory Peterson and James Fisher wrote about and illustrated every bird and place they could. Edwin Way Teale tripped across the continent in every direction, following three of the four seasons. The National Geographic Society compiled a photographic gallery of the highlights, and the Englishman Ivan T. Sanderson carved up the landscape into irregular provinces between magnificent photographs of *The Continent We Live On.* But there was plenty left to say and still an opportunity to bring into one wieldy volume a balanced account of North America. This Peter Farb has achieved at a pace that is never breathless yet using few unnecessary words.

He accompanies the reader on a simply conducted tour from the farthest Florida Key to the Mackenzie River, from the Gulf of St. Lawrence to the Gulf of California, from the highest pinnacle of the Sierra Nevadas to the bottom of Death Valley, from the arid Southwest to the trembling bogs of the Southeast. After sketching out the origin of the land, he skirts its watery rim, delights in its inland waters, surveys its many mountains, admires its great forests and grasslands, and considers how white men have changed it and how it has changed them.

A surprising amount of good science fits into place, each piece polished with modern discoveries and inlaid so exquisitely that no cracks show. A fine index leads one quickly back to the details included. There is no trace of the careful preparation that was made before this book took shape. Hidden are the choices made on which description to include, which feature to eliminate. Deftly the physical geography is explained when it helps the understanding of the scene. Native plants and animals inconspicuously appear and give color and life wherever needed. The reader who has been to the places described believes himself back again, with familiar place names all brought to mind. The reader who has not explored so far is given so clear a view that he is likely to feel, when he does visit the site, a sensation of having been there before.

Peter Farb has included seven pages of worthwhile readings, and an annotated list of the National Monuments, outstanding parks and preserves in each state except Hawaii, and all the provinces of

Canada south of the Northern Territories. We're not sure that a book as large physically as the *Face of North America* will fit, along with everything else, in the glove compartment of every automobile on the continent. But it is a volume that should go along on every trip, long or short, and be read to increase enjoyment and appreciation along the ways and byways, and off the trail as well.—*Lorus and Margery Milne.*

The Milnes have traveled more than 360,000 miles exploring plant and animal life on four continents. Lorus Milne, a Canadian-born naturalized American, is professor of zoology at the University of New Hampshire. The Milnes have written numerous science books including, The World of Night, The Senses of Animals and Men, *and their most recent,* The Valley, *reviewed on page 55.*

THE GENETIC CODE, by Isaac Asimov. The Orion Press, Inc., New York City. 187 pp. ($3.95); The New American Library, New York City. ($.60) Paperback. When Wilkins, Watson and Crick shared the 1962 Nobel Prize for their work in genetics, they opened the doors to science writers eager to explain the latest concepts in this relatively new science. The prolific Isaac Asimov is the first science writer of note to get his book on the market since the prize was awarded. He explores the complex functions of cell, chromosome, molecule and protein. He describes how the "blueprint" contained within the chromosome dictates the characteristics of an individual—how it insures a hereditary plan of appearance, intelligence and bodily structure. Although Asimov's latest work doesn't quite come up to the high standards set by his previous books, he does have a way of explaining the most difficult subject with a style anyone can understand.

MECHANISMS OF BODY FUNCTIONS, by Dexter M. Easton. Prentice-Hall, Inc., Englewood Cliffs, N.J. 371 pp. ($10.00). Although primarily written as a text for teaching an introductory course in human functional anatomy and physiology, there is a good deal of material in this book for the layman curious about the workings of the human body. The book is well illustrated and organized in a logical sequence.

EXPERIMENTS IN MAGNETISM AND ELECTRICITY, by Harry Scootin. Franklin Watts, Inc., New York City. 243 pp. ($2.95). Here are about 200 do-it-at-home experiments prepared by a high school science teacher. The book is divided into three sections: magnetism, static electricity and current electricity. The only equipment that has to be bought are some dry cell batteries and a spool of wire—the rest of the home laboratory can be found in any basement closet. The experiments are simple and provide a fine way to learn while doing.

GOMA, THE GORILLA BABY, by Ernst M. Lang. Doubleday & Company, Inc., Garden City, New York. 123 pp. ($3.95). Goma will be to gorillas what Elsa is to lions: the oft photographed animal darling tended as a member of a human family. Goma (meaning "dance of joy" in Swahili) is the first European born gorilla and the second gorilla born in captivity. When her own mother was unable to care for Goma, Dr. Lang, director of the Basel Zoo in Switzerland, took the one day old, four pound gorilla baby home with him. Dr. Lang's book reveals the first two years in the baby gorilla's life through wonderful photographs and an enthusiastic narrative which is affectionate without being sticky. Goma is toilet trained, taught to walk, play with a teddy bear, feed herself with a spoon and mind her manners by Dr. Lang and his wife, and at age two, seems a perfect little lady, if a somewhat rambunctious one. What is so touching is not only Dr. Lang's fondness for Goma, but the gorilla's unashamed dependence on her human family and her complete devotion to them. Dr. Lang's little book is thoroughly captivating.

Photos from Goma the Gorilla Baby, by Ernst M. Lang.

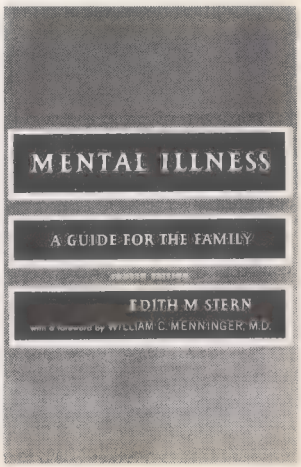
THE TWO FLASKS OF LOUIS PASTEUR, by Shelton Farrar. Carlton Press, Inc., New York City. 89 pp. ($3.00). The title of the book refers to Pasteur's attempt in the 1860s to explain the origin of life. Farrar uses Pasteur's experiments as a stepping stone to explain the cause, nature, and possible cure of cancer. It is the author's contention that cancer cells are formed from normal decay within the body. "When spores go to work to remove decay, a new life cell is formed. If formed in the human body, this new life cell is the cancer cell."

The book, loaded with half-truths and misinformation, presents an unusual approach to the origin of cancer. Farrar's cure is even more unusual. His belief is that cancer can be cured simply by controlling the diet. There are many obvious dangers in propounding theories not based on sound experimental evidence. Do-it-yourself cancer cures can usually be attempted only once.

PROFILES OF THE FUTURE, by Arthur C. Clarke. Harper & Row, New York City. 234 pp. ($3.95). This book is hard to keep up with; predictions keep appearing as accomplished fact! As early as 1945, Clarke wrote a paper on communications satellites, "Extra-Terrestrial Relays" published in *Wireless World*. The first broadcast from Telstar occurred during the production of this book.

The author also discusses ground effect machines, which ride on a cushion of air (and are now actually in regular use in England, see p. 64) He writes of three-speed mechanical highways with crossover points at various intervals, new concepts of gravity, and, of course, space travel. A part of the book originally appeared in *Science Digest*.

MENTAL ILLNESS, by Edith M. Stern. Harper & Row, New York City. 123 pp. ($3.00). The problems of the mentally ill are usually handled by men of the medical profession. But the fears and worries of friends and relatives of those who are ill are often overlooked. In Edith Stern's excellent book, she attempts to relieve the unnecessary suffering for both patient and relatives by presenting the problems of mental illness in a clear, easy to read fashion. This book was first published some 20 years ago; however, this revision contains new material covering the latest types of therapy and hospital procedure.



FRONTIERS OF DENTAL SCIENCE, edited by George C. Paffenberger and Sholom Pearlman. Scholastic Book Services, New York City. 160 pp. ($.50). A book geared to the scientific interest and understanding of junior and senior high school students must of necessity be verbally and conceptually simple; this book meets the requirements. The history of dental practices with which it begins broadly introduces the scientific areas which must be explored before dental research can go forward. Thereafter, in chapters of varying length, experts consider and explain how the body of knowledge intrinsic to the specific scientific fields—anatomy, biochemistry, biology, pharmacology, etc. — relates to oral problems. Because this body of knowledge is vast, only a summary can be offered, but in certain chapters, notably the one on genetics, the fascination of the subject, quite apart from its relationship to the teeth, should capture the imagination even of the child for whom science is drudgery.

There are, because of the nature of the subject, many repetitions concerning as yet unsolved dental problems. The presence of saliva in the mouth and its contribution to dental health are mentioned not once, but several times; the structure of tooth and jaw are frequently referred to both diagrammatically and verbally; the difficulty of preventing leakage in a filled tooth is amply demonstrated. The diagrams and illustrations themselves, however, are neither carefully chosen nor sufficiently elucidated. There are so many that they repeat themselves; eventually, the reader doesn't bother to look. A good diagram of the jaw can be instructive and memorable; a good picture of an instrument can describe its function. Only very rarely in this book do such excellences occur.

In the final chapters, which are concerned with unknown dental frontiers and the opportunities for research which they provide, interest is kindled by the direct quality of the writing and by the deceptively simple questions asked by the reader. Experiments that may answer these questions are suggested; it is probable, though, that any young dental researcher may be discouraged, if not by the difficulty of finding material, then certainly by the unlikeliness of corralling a friend who consents to be experimented upon. But as an introduction to the wonders and complexities of a few grams of ivory, the book accomplishes its purpose.

—Philip J. Dworetzky, D.D.S.

Dr. Dworetzky is an instructor of fixed partial prosthesis at the New York University College of Dentistry. He also serves as Career Guidance Counselor in dentistry at the Scarsdale High School, Scarsdale, N. Y.

CONQUEST, by David Alman. Doubleday & Co., New York City. 179 pp. ($4.95). A story of serious, at times seemingly unspectacular research. The book, based on CBS

News television broadcasts of the same name, shows how scientists are opening exciting new vistas for modern man—how research with porpoises may one day lead to sonar "sight" for the blind; how gerontologists, by nurturing specialized cells, can conceivably prolong man's life; how embryologists, by altering the chemical make-up of cells, may eventually be able to breed cows capable of producing twice their normal supply of milk.

Illustrations are used widely and well, making this true adventure story easy to read. The author writes clearly, at times skeptically, and with authority.

THE VALLEY, Meadow, Grove, and Stream, by Lorus and Margery Milne. Harper & Row, New York and Evanston. 173 pp. ($4.50). A pond, in late summer, is becoming stagnant for lack of oxygen. In order to avoid suffocation, the aquatic creatures that are able, escape from the water; insects spend their adult stages in the air, caddis worms transfer into caddis flies, dragonfly naiads become dragonflies. Minnows, which cannot survive out of their natural habitat, die of starvation.

The above dramatic scene and others are presented by the Milnes in microscopic intensity as they observe the land and water of their own New England River valley. Painstaking descriptions of flora and fauna are included in their perceptive book, and they are rendered exciting by the authors' imaginative style. An overall view of the area is vitalized with specific scenes of individual drama. We see, for example, the carnivorous pitcher plant systematically collecting water in its petals in order to trap and devour insects for its supper. The reader spies upon the preying mantis cleaning her feelers after a meal; she cleans them so well, in fact, that after each cleaning, the feelers are nibbled a bit shorter. We learn how a young parasitic species of wasp invades a caterpillar cocoon; after a time, no butterfly emerges, but a full grown wasp!

The Milnes conclude their informative book with a chapter entitled, "The Mark of Man." In it, disasters to the valley are described. Trees are chopped down for lumber and fuel; chemical sprays keep oaks and birches from returning; rich soil is buried by dynamite, bulldozers, and paving machines. Lorus and Margery Milne make it clear, however, that even these intrusions do not destroy the wild life of the area. Rather, wild creatures now share the valley with man.

CELLS: THEIR STRUCTURE AND FUNCTION, by E. H. Mercer. Doubleday & Co., New York City. Paperback, 135 pp. $.95. Since the development of the electron microscope, cytology, the study of cell structure and function, has made remarkable advances. In his book, Dr. Mercer lays the groundwork for a firm understanding of these developments by explaining the nature and dynamics of the cell.

Recent nuclear blasts boost space radiation hazard

Have man's nuclear tests outside the atmosphere contaminated space? The question in recent months has stirred up a scientific storm. What are the facts?

A bitter scientific controversy has been raging since last May when the United States disclosed that it planned a series of high altitude nuclear explosions over Johnston Island in the Pacific. Most controversial was the Starfish test of July 9. The explosion created an artificial radiation belt of greater intensity than had been expected outside the natural Van Allen radiation belt but did not result in any substantial "dumping" of electrons into the natural belt.

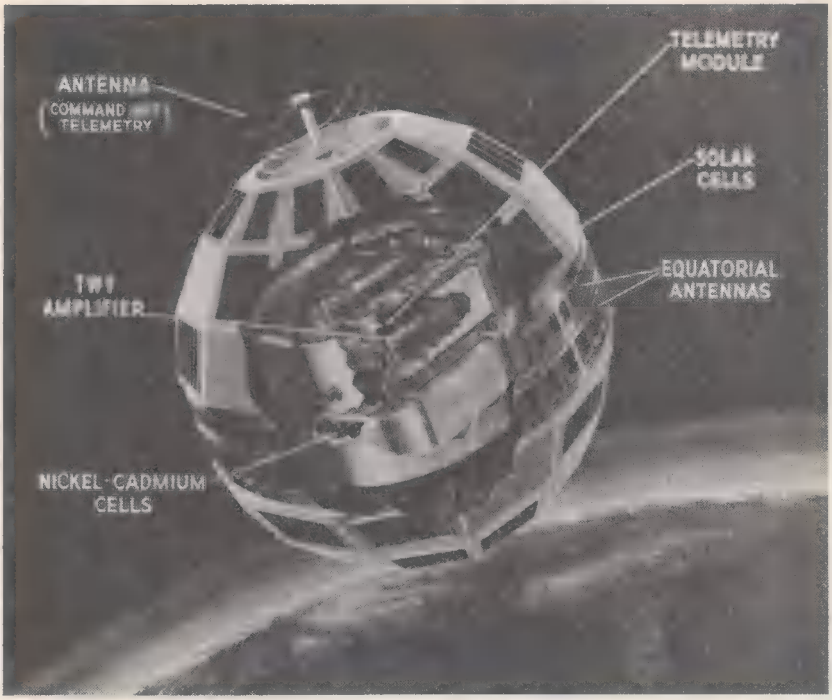
Last September, a Government report suggested that the artificial belt could last many years. Dr. James A. Van Allen criticized the report as "hasty and ill considered." He indicated that the President's Science Advisory Committee had pressured non-Government scientists in preparing the report. Dr. Van Allen forecast that the artificial radiation belt would be undetectable within a year.

Using information from the Telstar communications satellite and other radiation measuring satellites a later Government report seems to strike a middle ground between the previous Government estimates and those of Dr. Van Allen.

The Soviet Union, too, conducted nuclear tests in space. Understanding what the high-altitude tests are doing to space is vitally important in revising plans for future high altitude tests and in redesigning satellites to protect them from the artificial radiation.

On the following pages, Science Digest *reports what Telstar found and offers a basic outline of radiation in space.*

A cut-away view of Telstar, the communications satellite (top right). The cannister containing Telstar's electronics is laced to inside of the satellite frame for shock resistance. The TWT (traveling-wave tube) amplifier, boosts the strength of the one-billionth of ■ watt signal reaching Telstar from the ground to about 2¼ watts for retransmission to the earth stations. Solar cells convert sunlight into electrical energy that is storable in 20 rechargeable nickel-cadmium batteries. Equatorial antennas transmit and receive signals to and from ground stations. Aside from communications equipment, Telstar also contains radiation detectors (below right), that are designed to measure energy levels in the Van Allen radiation belts that surround the earth. Drawing of the detector shows details of the external structure and the shielding of the active elements.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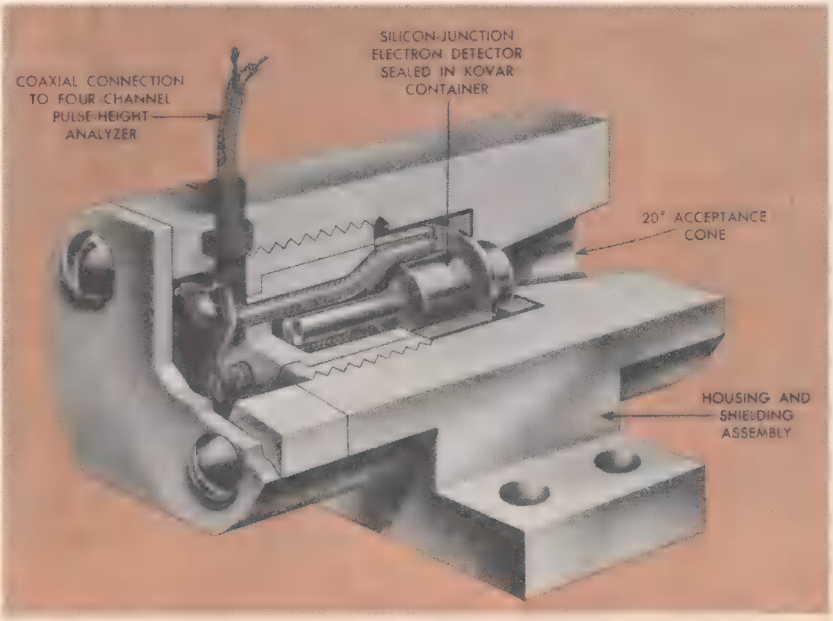
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SILICON-JUNCTION ELECTRON DETECTOR SEALED IN KOVAR CONTAINER
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HOUSING AND SHIELDING ASSEMBLY

LARGE increases in Van Allen belt radiation were caused by Soviet high-altitude nuclear tests. The Telstar communications satellite detected a significant jump in radiation following the Soviet high-altitude tests of last October 22 and 28.

Scientists are not yet agreed about what resulted from the U.S. nuclear test in space on July 9, 1962. The test, called Starfish, took place at an altitude about 250 miles. At the time, there were no radiation measuring satellites in orbit high enough to measure the effects.

After Telstar was put into its 600-to-3500 mile high orbit on July 10, however, it measured an electron intensity even higher than the intensity later recorded after the October Soviet blasts. How much of this July intensity was produced by the Starfish test is still a subject of debate. Large fluctuations are known to occur naturally.

Between the Van Allen Belts

The two concentric belts of intense radiation, called the Van Allen belts, bulge upward from the earth's atmosphere for thousands of miles. Walter L. Brown, head of the semiconductor physics research department of Bell Telephone Laboratories said that immediately after the Soviet blasts, the "gap" or "slot" between the two belts was nearly "filled up." There was less of an increase of electrons in the belts themselves than in this slot.

The number of electrons added by the Soviet blasts gradually diminished during succeeding weeks, but in the center of the slot the decrease was more rapid than it was on the sides of the belts and more rapid than would have been expected. After the Starfish tests, from July until October, the electron intensity in the slot showed a decay rate somewhat slower than the rate after the Soviet tests.

Scientists do not yet know the reason for the existence of a natural gap in the intense radiation. That is, they don't know why the region of radiation is not one continuous belt.

The Van Allen radiation can be compared to a vast uncharted ocean of protons and electrons, but it is an ocean whose presence was discovered only recently and whose properties are not completely understood.

Moreover, the study of radiation in space is difficult because the region is still not easy to reach and because satellites, which are always in specific orbits, cannot be everywhere at once when changes take place rapidly in the character of the radiation. The picture in space is altered drastically and rapidly by events on the sun and by manmade nuclear explosions.

The radiation is made up of fast-moving, or high energy, electrons and protons trapped by the earth's magnetic field. The way they got there is still not completely known. Some of the particles apparently come as ionized gas from the sun, for increased radiation has been observed following nuclear "storms" on

the sun's surface. It is believed also that some of the particles are produced by the interaction of cosmic rays with the outer atmosphere. Secondary particles that go back out into space are called the "albedo." The neutrons in the albedo decay into protons and electrons, some of which are trapped.

The trapped particles travel spirally along the earth's magnetic field lines, which arch high over the equator and come back to earth. As a particle nears the earth, the magnetic field around it increases. As the field strength increases, the spiral becomes flatter until eventually the particle is reflected and goes back out along the magnetic line or force. The process is then repeated on the other side of the magnetic field. The points of reflection are called mirror points.

Removing the Particles

Mechanisms are at work also removing the particles from the belts. There are a few molecules of very rarefied atmosphere in the Van Allen belt region, particularly near the mirror points, and some of the energetic particles are believed to impinge on these gas molecules. The molecules scatter the particles and release them from entrapment in the magnetic field. This tends to balance the gradual, natural increase of particles in the belts.

Other mechanisms are also apparently at work reducing the number of trapped particles in some regions of space around the earth to create the gap, or slot, of lesser radiation intensity and thus separate radiation into inner and outer belts.

Brown and John D. Gabbe, of the satellite systems engineering department, have deduced from the rapid decay in the slot that some sort of yet unknown "slot-cutting mechanism" is at work, in addition to atmospheric scattering.

Knowledge of trapped radiation in space is very recent indeed. It was discovered only in 1958 by Dr. James A. Van Allen, of the State University of Iowa, for whom the radiation belts are named. The discovery was made through experiments carried out by the satellites Explorer I and Explorer II, with additional information from Explorer IV and Pioneer III and general confirmation by Soviet satellites. The artificial addition of electrons to the radiation belts by high altitude nuclear explosions was predicted by N. C. Christofilos and demonstrated in the Argus high-altitude explosion of 1958.

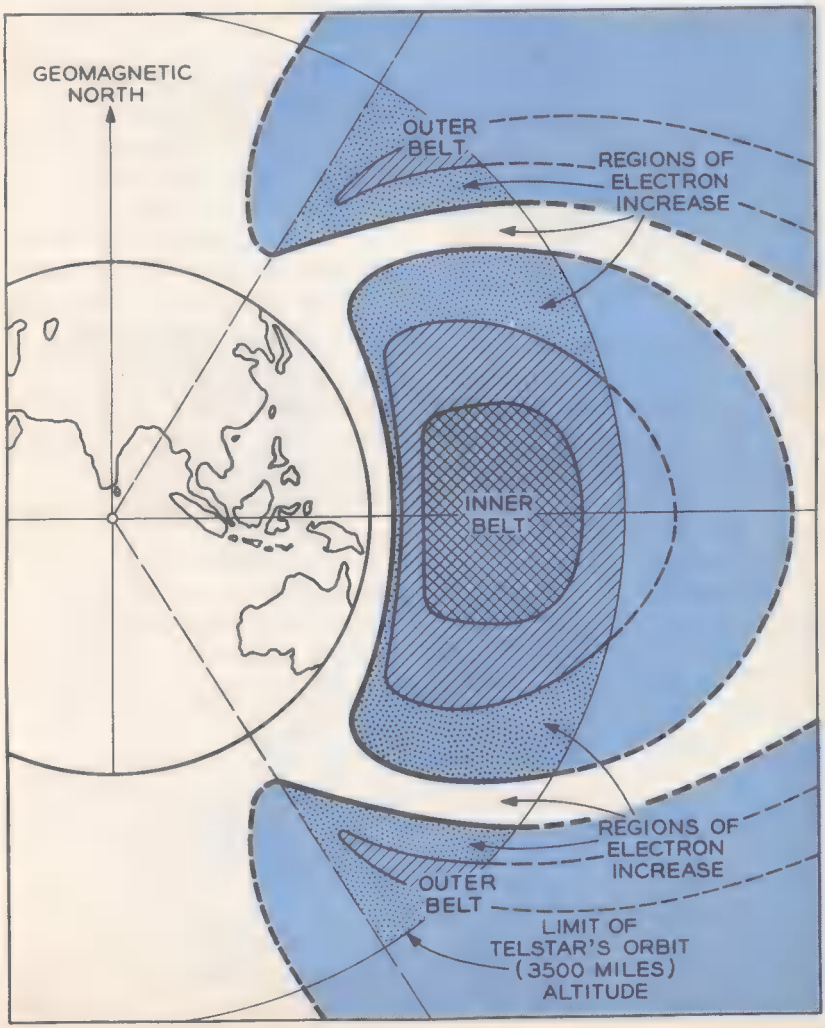
Telstar in its eliptical orbit passes through portions of both the belts. Since the day it was launched, it has sent telemetry data on radiation to ground stations around the world.

On November 23, Telstar stopped acting on commands from the ground because of the effects of radiation on transistors in its command decoders, although Telstar's telemetry continued. The level of radiation inside the canister had been 100 times as much as anticipated, because of high energy electrons. Bell Laboratories engineers managed to overcome the

(Continued on page 62)

An artist's representation of Telstar's launching from Cape Canaveral Florida and the satellite's first orbit around the earth (below). The Van Allen radiation belts, the bands of radiation that bulge outward from the earth's atmosphere for thousands of miles are shown as light shaded areas. A diagram (below right) of the inner and outer Van Allen belts, prior to the Soviet high-altitude nuclear tests of Oct. 22 and 28, was drawn from information transmitted by Telstar. The limit of Telstar's orbit is shown by the circle marking an altitude of 3,500 miles and by the lines radiating from the earth's center showing Telstar's maximum inclination, or angle from the geomagnetic equator. The regions of higher electron intensity are shown by progressively darker shading, but

are shaded only in the regions actually traversed by Telstar. The region shaded darkest had, in July, when Telstar was launched an electron flux of 800 million per square centimeter per second. After the Soviet nuclear tests in October, many electrons appeared both in the "slot" that separates the two belts, and at the sides of the belts. The electron increase was so great within the slot that it was nearly filled up. The number of electrons added by the Soviet blasts gradually diminished during succeeding weeks, but in the center of the slot the decrease was more rapid than it was on the sides of the belts. The decrease of electrons in the slot was somewhat slower after the U.S. test in July. Scientists have deduced that some sort of yet unknown "slot cutting mechanism" is at work.



(Continued from page 59)
malfunction, however, and Telstar at the time of this writing was operating normally.

In discussing radiation in space, it is helpful to understand some of the terms used. Over the years a special vocabulary, based on the physics and mathematics of radiation, has evolved among scientists and engineers to describe radiation.

The Language of Radiation

The *electron volt* is a unit used to describe the energy of a particle. It is the energy transferred to one electron when it passes from one region to another having a difference of electric potential of one volt. A particle having a greater amount of energy has greater instantaneous velocity.

The electrons that strike the face of a television picture tube to produce the picture each have an energy of about 15,000 electron volts, for a typical television tube. The particles in the Van Allen belts have energies in the millions of electron volts, abbreviated "mev." Other units sometimes used are a thousand electron volts, "kev," and a billion electron volts, "bev."

Flux of particles in space refers simply to the number of them that pass through a given surface (of given area and direction in space) per unit of time.

The particles in a flux may have many different energies. The distribution of energies of particles in this flux is referred to as its *spectrum*.

The *intensity* of radiation is the total energy of particles flowing through a unit area per unit of time, and is dependent on both the flux and the spectrum of the flux.

The *direction* of movement of a particle is implied in velocity. The direction in which particles are moving in various parts of space is important to an understanding of the Van Allen belts.

The flux and spectrum of Van Allen belt radiation are known to vary from one region of space to another and to vary in each region from one time to another. Space radiation experiments try to measure these properties with appropriate instruments placed aboard satellites and probes.

The measurements are analyzed in an attempt to arrive at charts of the Van Allen belts and eventually an understanding of the mechanisms that produce them. With greater understanding, the harmful effects of radiation on equipment can be minimized, and long-life satellites can be built and orbited.

Basically the instruments attempt to separate the particles into different energy ranges and to count the numbers of particles in these ranges being encountered at that time, perhaps a few seconds, and at that location in space.

To do this, scientists and engineers who design the instruments must make assumptions about the kinds and energies of particles expected, and then design and calibrate instruments accurately. Receiving the measurements on earth, they must take into consideration the location and orientation of the satellite at the

time of each measurement and translate the measurements into terms that can be compared with measurements obtained from other satellites. This can become a massive project. Telstar has already reported almost two million measurements of radiation in space.

Further, the instruments in one satellite report in terms different from the instruments of another. Their orbits also differ. Proper interpretation of the data frequently is a subject of scientific debate.

The measurements from Telstar showed that prior to the Russian nuclear tests in October, fluxes of electrons were relatively stable in Telstar's orbit. The flux was about 3 million electrons per square centimeter per second on a magnetic field line that crosses the equator at 4,500 miles altitude. After the second explosion, the flux there was about 500 million electrons per square centimeter per second. This field line is on the high-altitude side of the inner Van Allen belt.

The relative increase was even greater in the center of the slot region between the two belts. Electrons in the slot increased about 1000 times.

In July when Telstar first went into orbit, radiation was also high. Then the flux of electrons at the peak of the inner Van Allen belt was about 800 million per square centimeter per second.

The energy spectrum of the added electrons is roughly what would be expected from a nuclear fission explosion, but is apparently slightly "softer," or of lower energy than, the spectrum in some parts of space before the October tests.

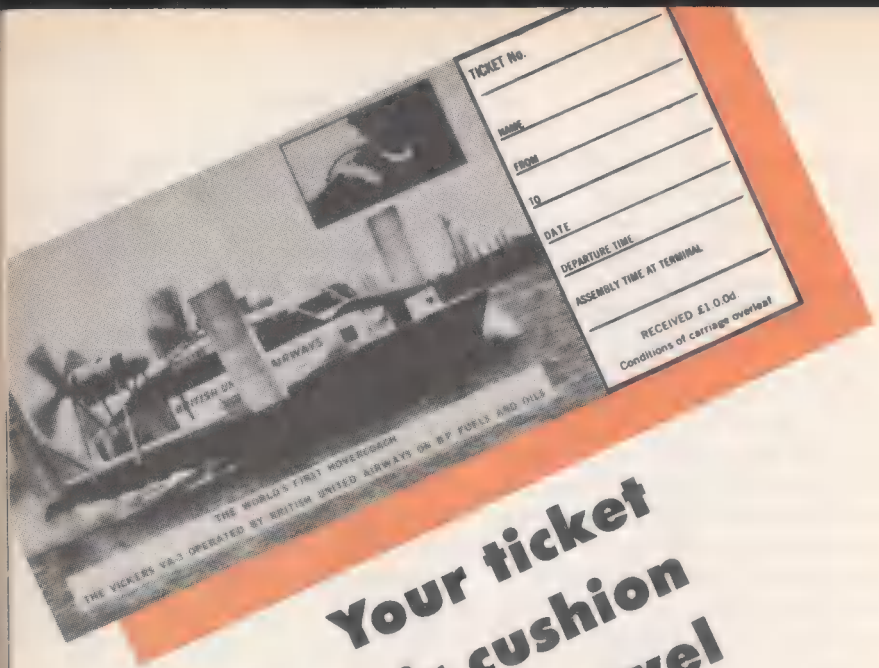
TEST PROPOSED FOR EINSTEIN THEORY

A FLARING STAR 900 trillion miles from the solar system may provide a testing ground for that part of Einstein's theory of general relativity that predicts the existence of gravitational waves.

The celestial object, Nova Sagittae, actually consists of two stars. Only 81 minutes, the shortest known period of orbital motion, are required for one revolution of the eclipsing system. The system consists of a visible dense white dwarf star and one other star not optically observable.

The stars are believed to be rotating around a common center so fast —at 1,500,000 miles an hour—that energy is radiated as gravitational waves. Since Nova Sagittae is very faint, astronomers have not been able to determine whether the second object of the pair is another dwarf star, a cometlike mass of gas circling the dwarf, or a ring with a mass in it circling the white dwarf. The entire system is much smaller than the sun.

Drs. Robert P. Kraft and Jesse L. Greenstein of Mt. Wilson and Palomar Observatories, with Dr. Jon Matthews, California Institute of Technology physicist, collaborated in pointing out the significance of Nova Sagittae in proving part of general relativity theory. Known as a recurrent nova, the star flared nearly to naked eye visibility in 1913 and in 1946.



Your ticket to air cushion travel

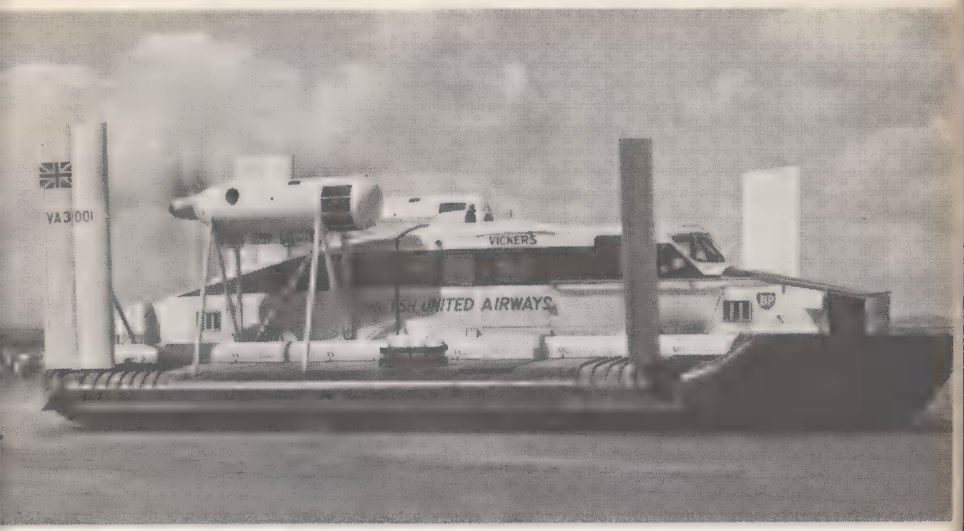
Great Britain now has the world's first regularly operating service using an air cushion vehicle. Continuing development promises a bright future for this remarkable form of transportation.

by Trevor Holloway

THE distance between Dover and Calais is only 20 miles. But because of the choppy English Channel it is a rough 20 miles to cross. Future travelers, however, may glide over this tourist nuisance quickly and smoothly.

A hint of crossings to come was seen in June 1959 when a British Hovercraft first rode above the waves that separate England from France. Identified as the SR-N1, this full-scale research craft was lifted above the choppy surface of the channel by a cushion of compressed air.

The principle on which this and other air cushion vehicles operate is fundamentally the same: a lift principle that raises them above the bumps of roads and the waves of waterways. The lift principle is, in

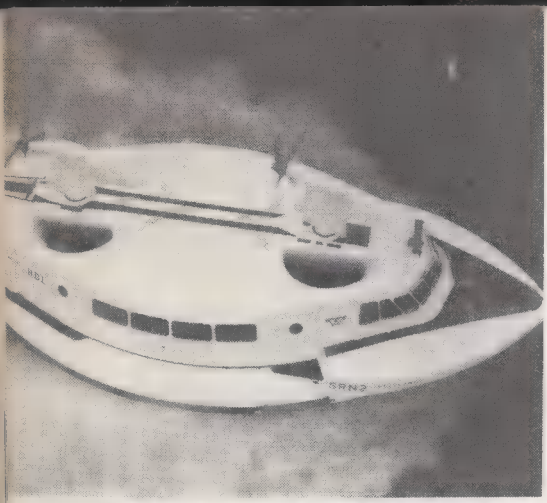


Thousands of people in Britain have already bought tickets (opposite page), and experienced a ride on the world's first air cushion craft to operate a scheduled service. The 19-mile sea journey from Rhyl, in North Wales, to Wallasey in Cheshire, takes 25 minutes. The service substitutes for a 41-mile trip by car. The vehicle used for this historic trip is the Vickers Hovercraft VA-3, (above) a ten ton vehicle with a capacity of 24 passengers or just over two tons of freight and a speed of 60 knots.

essence, a cushion of compressed air generated between the bottom of the Hovercraft and the surface over which it will travel. In the vehicle, a large fan sucks air downward through an air duct and forces it—at greater pressure—into a chamber beneath the craft.

How is the air cushion contained beneath the vehicle? The cushion is surrounded by a curtain of higher pressure air that flows from the vehicle to the ground itself. The nozzles through which the air for the curtain is ejected face inwards toward the center of the craft. Thus the flow of air for the curtain holds in the air of the cushion which it surrounds. Upon reaching the ground, the air curtain is bent outwards. It is the amount of force required to bend the curtain outwards that determines the magnitude of the cushion pressure that can be built up and sustained. The thrust required to provide the curtain is very small in relation to the weight of the craft.

Since the curtain of air travels along with the craft, it serves to replenish any losses in the cushion. The stability of the vehicle is assured by the increase of the cushion pressure as the space between the craft and the ground diminishes. If the vehicle rises above necessary travelling height, it suffers a loss in lift.



2

3

1. The SR-N2 glides above the surface of the water. The semicircular ducts on the top of this vehicle supply air to the inside fans which create the vehicle's air cushion and air curtain walls. The two propellers atop the craft provide the thrust for forward propulsion.

2. The roomy Britten-Norman "Cushioncraft" CC-2 "floats" one foot above the surface of the earth in a demonstration. The vehicle can accommodate eight passengers.

3. In a demonstration for the Prime Ministers of the British Commonwealth of Nations, the SR-N1 Hovercraft whizzes by the Houses of Parliament in London. Although purely a research craft, the SR-N1 has provided valuable information that has influenced the successful development of other British air cushion vehicles. The SR-N1 has approached speeds of 50 knots.

For Hovercraft, the operating height is determined by approximating one-tenth the diameter of the vehicle. A Hovercraft with a 50-foot diameter would have a maximum traveling height above ground of five feet. But a hoverheight of three feet is usually adequate.

Hovervehicles are moved by propellers. The experimental vehicle SR-N1, which crossed the Channel, had a four-bladed axial fan which supplied both the air for the cushion and curtain as well as the propulsive thrust.

The system that first lifted and moved the SR-N1 had been conceived ten years ago by an electronic engineer, C. S. Cockrell, who saw the possibilities of a ring-shaped cushion-curtain system in which the air cushion supporting the craft is contained within a peripheral ring of higher pressure air. His first Hovercraft was powered by a vacuum cleaner motor and a fan bought in a junkyard.

For three years, Cockrell's plans were shunted among various British government departments and were finally handed back to him when government experts mistakenly decided that Hovercraft had no military applications. Eventually the National Research and Development Corporation became interested and formed a subsidiary company known as Hovercraft Development. Ltd. Its object was to organize research and coordinate activities among member firms that were interested in developing the surface-skimming vehicle.

This lack of duplication of effort seems to have given Great Britain claim to a two year lead in the development of this new method of transportation. The first commercial Hoverferry service in the world was inaugurated in July 1962. The vehicle accommodated 24 passengers.

That it came about at all is the result of lessons learned in designing and building earlier Hovercraft. Experience gained during the trials of the SR-N1 enabled the Saunders-Roe Co. to build the SR-N2, a 27-ton passenger or car ferry for over-water operation, with a cruising speed of 70 knots. (A knot is

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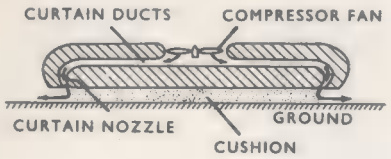
Author Trevor Holloway is a contributor to leading publications in Great Britain and abroad. He does his writing in Westbury, Wiltshire.



In a Hovercraft vehicle the cushion of air is contained by a curtain of air, which is ejected at a higher pressure. The air of the curtain acts as a solid wall against the escape of the cushion air. The curtain extends from the bottom of the vehicle to the ground.

equivalent to one nautical mile, or 6,080.20 feet, per hour.) Two ducted fans provide the air curtain jets, and two propellers supply the thrust for forward propulsion. Sixty-six passengers can be accommodated in the central cabin.

Final preparations are now ready for building the SR-Mk.2, the first Saunders-Roe air cushion vehicle actually designed for commercial operation. The new craft is a stretched SR-N2 with accommodation for 150 passengers. Cruising speed will be 74 knots and freight capacity 12 tons. Power is provided by four gas turbines. An integrated lift-propulsion system is used to permit the choice of power arrangement best suited to prevailing sea conditions. For example, in relatively smooth seas additional power can be fed to the propulsion propellers at the expense of hoverheight, thus greatly increasing speed.

What commercial applications are foreseen for the Mk.2? As a passenger vehicle carrier, it could carry three cars, eight motorcycles, and 32 passengers. It will also be particularly useful to transport prepacked freight. High overwater speed and the ability to move freely from land to water make it ideal for use as either a police or rescue launch.

Among the smaller firms associated with Hovercraft Development, Ltd., Britten-Norman, Ltd., of Bembridge Airport, Isle of Wight, has an air-cushion transport vehicle already in production and sales have been made to the Ministry of Aviation and to the British Army for research purposes. The Cushioncraft CC-2, is of light and extremely graceful design. It is powered by a Rolls-Royce eight-cylinder automobile-type engine which gives a maximum speed of 45 m.p.h. and a maximum range of 360 miles. Hoverheight at normal gross weight is 12 inches, and 22 inches when empty. The dimensions of the CC-2 are: Length, 20 feet; beam, 17 feet; height to top of fins, 8 feet 6 inches.

Dismantled for Transportation

Able to travel over metalled surfaces, rough ground, water, ice, tidal areas, and mudflats, it is fast, creates little spray and no wash. The CC-2 is adaptable to many applications and is available now. The structure is so arranged that the craft may be dismantled into three sections to simplify transportation. A permanent bench seat in front of the engine houses the driver and one passenger. Space is available to seat eight other passengers.

The design of the CC-2 was much

influenced by the company's experience when building the CC-1, a transport vehicle built specifically for banana shippers, who were seeking a more satisfactory method of directly transporting bananas from plantations to ships. Among the many other roles suggested for the CC-2 are airport and river firefighting, operation over weed-infested waterways, military applications, and amphibious cross-country transport.

Trial Runs for the VA-1

Vickers-Armstrongs, Ltd., turned its attention to the field of air-cushion vehicles in 1959. Within 12 months a research craft, the VA-1, with a simple single-duct lift system, was performing well in trials. Next came the VA-2, designed and built for demonstration purposes. A small utility vehicle, powered by three light aircraft piston engines, two for lift and one for propulsion, it was capable of carrying up to five passengers at a speed of 40 knots. To facilitate its loading into transport aircraft, it was designed in the form of readily detachable sections.

Latest and largest of the Vickers Hovercraft to be completed is the VA-3, the world's first air-cushion craft to operate a scheduled service, a 25-minute, 19-mile sea journey from Rhyl, in North Wales, to Wallasey in Cheshire. The service was a welcome substitute for the normal 41-mile trip by car over congested highways.

With a capacity of 24 passengers or just over two tons of freight and a speed of 60 knots, the VA-3 is ideal for such offshore service. British United Airways, which operates the service, sold several thousand tickets long before the VA-3 set off on her maiden run. Passengers have been greatly impressed by the speed and comfort of the trip.

The VA-3 is a ten-ton vehicle, powered by four free-turbine engines. Overall length is 54 feet nine inches, with a beam of 27 feet. In the role of fast passenger ferry or personnel transport, it can operate in estuaries and similar waters where its amphibious capabilities allow it to operate in water with waves up to two feet, and over shoals and mudbanks. For survey, exploration, and patrol, the VA-3 can be fitted with a cargo area and could then carry some 4,000 pounds of equipment and crew, for 80 nautical miles at high speed.

For High Speed Service

Plans for a still more advanced model are already in hand at the Vickers works. This is type VA-4, a craft capable of speeds up to 80 knots. It is designed primarily to operate a frequent high-speed service to offshore islands in the more sheltered seas and channels.

Vickers is also conducting a great deal of research into another and unique application of the air-cushion principle. Farm and other vehicles are frequently handicapped, if not completely immobilized, by rain, snow, and ice. An air-cushion

conversion kit has been designed to fit around the waist of a Land Rover truck. The adjustable "skirt" contains the cushion of pressurized air which can take any desired proportion of the vehicle's weight off the wheels. As the degree of lift can be varied and controlled at will, the vehicle can be given the appropriate degree of traction required for any particular type of difficult surface.

Used as Farm Machinery

Trials in which an "air-cushioned" Land Rover sprayed crops and liquid fertilizers, showed that the vehicle was able to operate efficiently under conditions in which conventional farm machinery would have bogged down. As the conversion kit is so easy to fit to standard trucks, it is easy to appreciate what a boon such an "air-lift" would be to contractors, oilfield companies, and others who must operate in waterlogged or other soft surface conditions.

Yet another variation of the air-cushion principle is being developed by the Scottish firm, William Denny & Brothers, river vessel specialists.

The Denny D.2 Hoverbus differs from most Hovercraft inasmuch as it is a "sidewall" type. The sidewalls, or "skirts," extend down either side of the craft to contain the air cushion on which the craft rides. These sidewalls are still submerged when the craft itself is airborne, the air cushion being contained at either end of the craft by jets of air. Although not suitable for operation overland, the Hoverbus requires very little depth of water in which to operate. Practically no spray is produced by the jet system, the noise level is low, stability of the craft is excellent, and no waves are created to embarrass small craft in the vicinity or to damage banks of rivers or canals.

The Hoverbus is designed to operate at a service speed of 25 knots, carrying a maximum of 88 passengers or about six tons of cargo. It has a length of 83 feet and a width of 19 feet. Four engines provide a total of 800 h.p.

EVIDENCE of poison gas has been discovered on Mars. Recent spectroscopic studies of the red planet suggest that the Martian atmosphere, which is largely nitrogen, also contains nitrogen peroxide, a reddish-brown poisonous gas.

The presence of nitrogen peroxide on Mars could explain the shifting polar caps, seasonal variation in its dark areas, the so-called dust storms, and perhaps its red color. These phenomena may be evidences of oxides of nitrogen responding to temperature changes. If the gas is present on Mars, there could be no life there as exists on earth.

The spectrum analyses of Martian light were made by Dr. C. C. Kiess, of the National Bureau of Standards, and the Army Corps of Engineers and the National Geographic Society.

(Continued from page 3)
ments on the dangers of overpopulation in the past. Please let's have more of this sort of information in language comprehensible to non-bureaucrats.

Incidentally, every source on which I can lay my hands indicates that the current population doubling time is closer to 40 years instead of Dr. Weinberg's 100 years. That's quite a difference! What he probably meant but didn't make clear was that the average doubling time over the past "250 or 300 years" may have been 100 years.

R. W. Van Alstyne
Live Oak, Calif.

That's Life

In "Life on Unseen Planets" (February '63) Dr. Harlow Shapley states "No miracles are required for the beginning of life, no supernatural operations, just the right temperature, the right chemicals, and plenty of time for biochemical evolution." What a careless smug statement. There's nothin' to it. Just put 'em together and Bingo! There's life. This statement is subject to proof. Science has all the answers to what is required for life. All they have to do is collect their amino acids, nucleic acids, their proteins, and macromolecules, and everything else they need, and shake them up together, put them in a warm place, and then stand back and watch them hatch. This is something that can be demonstrated. They speak of it as if it had already been done. Just a simple procedure. I deny it and call on them for proof. Real proof, not suppositions. If their theory is right, then they can create life, and they should be able to do it instantly, for they already have all the ingredients. They do not have to wait, as they say nature did, for all the elements to be accidentally brought together.

Aaron Reeder
Mt. Erie, Ill.

Table of Contents

I keep my copies of *Science Digest* and refer to them often. I find that they are too good to throw away and that my mind is not good enough to remember all that they contain.

Looking over *Science Digest* a few years back, I noticed that on the front cover was the table of contents which struck me as being very helpful. In the present issues I would hesitate to trade the attractive front cover for an unattractive table of contents so why don't you put the table on the back cover? This would save time for people who like to refer to back issues or like to see what their new *Science Digest* contains each month. Thanking you for a wonderful magazine.

John S. Norwood
Black Mountain, N.C.

Review the Quiz

I enjoy going over the *Science Digest* quiz in the recent issues. I think it is a good idea to have it for readers. I always get more out of reading your magazine when I review the quiz.

Philip J. Kline
Breman, Ind.

Wonderful Service

I have enjoyed *Science Digest* and its articles for many years. I believe that you are doing a wonderful service for the reading public.

Gordon Serjak
Tyler, Texas

the progress of

by Arthur J. Snider

THALIDOMIDE CAUSES DEFORMITIES IN MOUSE LITTERS

Mice given thalidomide during pregnancy have given birth to deformed litters. The effect of the drug on gestating mice was studied at the Roswell Park Memorial Institute, Buffalo, N. Y.

According to Dr. Joseph A. DiPaolo, "when thalidomide was given 62 pregnant mice, seven litters contained embryos with congenital abnormalities. No abnormalties were found in control groups," the doctor reported.

The drug also appeared to reduce the number of embryos this strain of mouse usually bears, and the number of abortions was higher in thalidomide-treated mice than in members of the control groups. The incidence of abnormalities may prove to be greater when further studies are completed, Dr. DiPaolo said.

The embryo abnormalities included phocomelia, a congenital malformation in which the long bones of one or more of the arms or legs fails to develop. An increased incidence of phocomelia was reported in human babies when thalidomide was taken early in pregnancy.

In producing thalidomide-associ-

ated defects in laboratory animals, however, difficulties have been encountered. Studies with rats, similar to those with the mice, produced no malformations, Dr. DiPaolo said. Further animal experiments are necessary to permit a detailed study of the exact causes of the deformities.

ELECTRONIC EAR DESIGNED FOR TOTALLY DEAF

Surgically implanted "ears" may return the sense of hearing to the totally deaf. According to Dr. John B. Doyle, Jr. of Los Angeles, the experimental "ears" substitute for the cochlea, the organ which sets up the waves that stimulate the auditory nerve. The two-ounce experimental ears, one-inch square and a half-inch deep, have already been placed in the skulls of two patients.

Unlike today's hearing aids, which merely amplify sound, the new "ears" are designed to help those who cannot hear any sound at all, no matter how greatly amplified. These people have lost, either through accident or illness, the mechanism that converts air vibration into sound.

The new device consists of two tiny induction coils. One is imbedded in the skull with wires running to the cochlea. The other coil, worn externally, generates a magnetic field which acts upon the imbedded coil. One is a transmitter; the other is a receiver. Dr Doyle believes the units will eventually be minaturized so that they can be implanted in the ear opening. A small wire would lead from the device to a pocket battery case.

Present models can give only the rhythm of speech, but it is expected that a unit, designed for permanent installation, will give the patient a reasonable degree of intelligibility.

'OLD AGE' LUNG DISEASE DIAGNOSED IN YOUNG MEN

Emphysema, a lung condition marked by shortness of breath and cough, is usually associated with older men. But Dr. Paul N. Seebohm of the University of Iowa College of Medicine has diagnosed the disease in ten men who ranged in age from 29 to 39. Although the traditional hypothesis is that emphysema starts with chronic bronchitis, none of the ten young men had chronic bronchitis. In proposing an alternate hypothesis for the cause of lung emphysema, Dr. Seebohm believes that there is an inherent defect which produces bron-

chial changes. After the disease is well underway, the classic symptoms appear; namely, cough, bronchitis, and lung disability. The nature of the tissue defect remains unknown.

Some researchers believe that smoking produces a toxic change in the lungs and is a cause of emphysema. All of the ten patients examined smoked, but Dr. Seebohm says he has seen older patients with emphysema who were nonsmokers. The ten patients had only a few "pack years" in their experience, he points out, while many older men have smoked for many years and have normally functioning lungs.

SKIN CANCER DEPENDS ON SUSCEPTIBILITY AND LUCK

Anyone exposed regularly to sunlight has some cancerous tissue in his skin, in the belief of Dr. Harold F. Blum of the National Cancer Institute, but in most cases the skin tumors never become recognizable in the individual's lifetime.

It would seem a good practice, he says, to avoid excessive exposure to sunlight. This does not mean shunning sunlight entirely but only avoiding the tiny fraction that ordinarily affects the skin. This fraction, ultraviolet light, is screened out by window glass and is virtually lacking before 8 A.M. and after 4 P.M., even in midsummer.

Animal experiments show the development of skin cancer induced by ultraviolet light is continuous, beginning with the first dose, or shortly thereafter. In most cases the tumor develops so slowly that it does not reach recognizable size within the lifetime of the person bearing it. In the population as a whole, Dr. Blum adds, only a certain proportion will be unlucky enough to develop cutaneous cancers within the normal span of life. Development depends upon the amount of exposure to sunlight, individual susceptibility, and luck.

WHY DOCTORS MUST WORK OVERTIME

If you wonder why your physician can't give you an immediate diagnosis, consider this:

Ninety percent of complaints brought to the average physician consist of a scant two dozen symptoms, says Dr. Edward R. Pinckney of Hollywood, Calif. In the book, *Medical Encyclopedia of Common Diseases,* Pinckney alphabetically lists the most common complaints as abdominal pain, anxiety, appetite loss, chest pain, constipation, cough, depression, diarrhea, difficulty in breathing, dizziness, fever, frequency of urination, gas, headache, insomnia, nervousness, numbness, overeating, overweight, pain on urinating, palpitations, swelling of the ankles, tiredness and weight loss.

Each of these must be broken down. There are, for example, 23 causes of headache.

DEVICE RECORDS RADIATION IN 13 DIFFERENT SITES

A whole-body radiation counter, capable of recording separately the

amount of radiation in 18 different sections of the body, is operating at the National Institutes of Health, Bethesda, Md. In addition to making it possible to detect the most minute amounts of radioactive material within the body, the counter will determine what part of the body the radioactive material is in. The counter will be used in studies seeking to learn how radioactive iodine from fallout gets into the bodies of infants and small children and how long it remains. Another study will evaluate the effectiveness of various types of shielding.

The instrument takes only two or three minutes to count the total amount of radiation in the body. More detailed studies may take a half hour or more. Six-and-a-quarter-inch thick armor plate salvaged from old battleships was used to construct the rooms in which the whole-body counter is located. Old armor plate, now quite scarce, is necessary to reduce background radiation to a minimum.

National Institutes of Health

A transparent manikin, "Christine," is lowered into the U-shaped trough of the National Institutes of Health's new whole-body radiation counter by Dr. Howard L. Andrews and his assistant, Dorothy Peterson. By filling any portion of the manikin's body with a known quantity of radiation, the accuracy of the counter can be checked. The counter is used to record radiation from 18 different parts of a patient's body.

FIGHT FIRE WITH FIRE IN TREATMENT OF CANCER

To extinguish a fire you wouldn't douse it with kerosene. Yet that approach is being tried at the University of Chicago Clinics to fight advanced breast cancer. The results are surprisingly favorable in the first cases tried.

The extinguisher is a combination of two female sex hormones injected daily. Normally, female hormones would be expected to stimulate breast cancer growth in women because many tumors are what doctors call "hormone dependent." But a combination of the two, estradiol and progesterone, had produced "measurable and clinically worthwhile improvement" in nine of 15 patients in whom the cancer had spread through the body.

All of the patients were at or near the end of any effective treatment. They had been improved at various times by other methods of diminishing hormone support, but the improvements had subsided.

The new treatment was devised by Dr. Richard L. Landau, Dr. Edward N. Ehrlich, and Dr. Charles Huggins. They said the improvement to be afforded by the new combination is limited in duration, but a few cases showed dramatic improvement. One patient went back to work.

It appears that the two drugs do not totally extinguish the tumor but provide a retarding effect. In some patients the tumors persisted but did not impair the general health of the patient. Current research is involved with trying different dosage combinations and devising synthetic drugs for trial.

HORMONE COSMETICS DON'T REMOVE SKIN WRINKLING

Despite advertising claims there is no scientific evidence to show that hormones used in cosmetics produce any favorable effect in wrinkled skin, says Dr. John S. Strauss, of Boston University School of Medicine.

Application of the female sex hormone, estrogen, has in some instances induced changes that might tend to reduce wrinkling by increasing elasticity of the skin and causing it to thicken slightly. But the effect is practically microscopic in scope. "The experimental laboratory result in which a decrease in the depth of a skin fold from treatment is measured in terms of a few microns means little to the average female, who does not walk around with a micrometer to measure wrinkles," said Dr. Strauss.

It has also been claimed that estrogen applied to the skin will prevent "aging." This has not been studied in humans; and indeed it would require an extensive long-term investigation, the dermatologist said. In animal experiments, hormones do not prevent development of senile skin.

There is no indication that the use of a small amount of estrogen will produce any harmful side effects on the body, but there may be a hazard to those who use excessive amounts of a cosmetic containing the hormone.

Alabama boneyard sheds new light on whales

Some 70 million years ago the seas were ruled by a toothy 60 foot monster called the zeuglodon. Recently a farmer working his cotton-field ran his plow right into the bones of one of these giant whales of ancient times.

by Walker D. Wallace

THE Tertiary era, which began some 70 million years ago, was a time of great change and development for mammals. By the beginning of the Tertiary, mammals had already been on earth 100 million years. But, perhaps because of the dominance of the dinosaurs and other giant reptiles, their development had been limited.

In earlier ages, furry, mouse-sized mammals probably went unnoticed by the giant dinosaurs. During the evolutionary explosion of the Tertiary, however, it was descendants of these tiny creatures that became the giants of the land and of the sea.

Today, on the land, most of the giants have disappeared, leaving only the elephant to remind man just

how immense land mammals can get. In the sea, however, the giantism that began in the Tertiary is still seen in several varieties of whales. The largest modern whales are placid creatures feeding on vast quantities of microscopic sea animals and plants. During the Tertiary, the giant ancestors of these whales were equipped to hunt larger prey.

One of the most fearsome looking, and most well known of these ancient whale-like creatures is the zeuglodon, a toothy, 60-foot, 180,000-pound monster that roamed the seas of the world. During the reign of the zeuglodon, a considerable portion of the southern states were at the bottom of the Gulf of Mexico and zeuglodon bones have been found scattered over portions of the cotton-lands of South Alabama. So common are these fossils that certain geological formations in Alabama's Choctaw and Washington Counties are known as zeuglodon beds.

In July 1961, a farmer working his cotton-field near the little town of Millry, Alabama in Washington County, ran his plow into the vertebrae of a zeuglodon. A state Department of Agriculture agent, checking the cotton acreage of the farmer heard about the find and immediately contacted Dr. E. F. Richards, head of the Geology and Geography Department of the University of Alabama. Within two weeks a team of university students, headed by Dr. Douglas Jones, was on the site digging up the remains of this ancient whale.

The Alabama team only had to dig four feet into the clay to uncover the bulk of the fossil. Over the centuries since the creature died and was buried in the mud at the bottom of the expanded Gulf of Mexico, the sea bottom had been changed to dry land. Erosion had almost exposed the bones. In fact, Dr. Richards believes that the skull of the creature has already been destroyed by the farmers plowing in the field.

Although the fossil was not deep in the ground, digging was still a tedious process. After a piece of bone was located, picks and shovels were discarded for more delicate instruments. Small knives were used to carve the clay from the bones. During the early part of the excavations Dr. Richards said, "We're only exposing the bones and leaving them to harden in the sun. Later we'll wrap the fossil material in wet newspapers and coat them with plaster of Paris to protect them for transportation to the University." These precautions are taken to prevent the bones, some of which are fragile, from breaking.

Photos: Gus Robinson

1. At the site of the zeuglodon fossil find Dr. Douglas Jones and a team of University of Alabama students (background) work on excavating the creature's rib cage. In the foreground an orderly row of vertebrae have been exposed after digging only a few feet. The skull of the creature may have previously been destroyed by farmers plowing the land.

2. Dr. Jones examines the zeuglodon vertebrae unearthed at the site.

3. After the fossil pieces are located picks and shovels are discarded for more delicate tools such as knives which are used to carve the clay from the bones. Students and younger helpers painstakingly prepare parts of the fossil's rib cage.

2

3

Fossils of the zeuglodon and other sea animals were once so common in southern Alabama that the bones were collected and burned for lime, but the recovery of complete or nearly complete skeletons, rather than scattered bones is relatively rare. Because of this and the difficulty and expense of excavating and restoring a fossil the size of this ancient whale, only two complete zeuglodon skeletons have ever been assembled. One, on exhibition in the U. S. National Museum in Washington D. C., is a composite, restored from parts of skeletons excavated by Charles Schuchbert in 1894 and 1896 in Choctaw county. The second skeleton was housed in Wood's Museum in Chicago, but the museum and its contents were destroyed by the great Chicago fire.

The skeleton dug up at Millry may not be on public exhibit for a while, since lack of funds has hampered the University from getting it into shape for exhibition at the museum of Natural History on the main campus at Tuscaloosa. The immense task of assembling a fossil of this size can be imagined from Dr. Alexander Winchell's description of the skeleton at the National Museum. It "possesses 118 vertebrae, of which 91 are genuine, and 21 factitious (a model of a portion of the skeleton that is substituted for the missing part). The neck embraces six vertebrae. There are 36 pairs of ribs. The cranium or head is six feet long; the jaws are each armed with five grinding teeth on each side, preceded by two premolars and one incisor on each side of the middle," says Dr. Winchell.

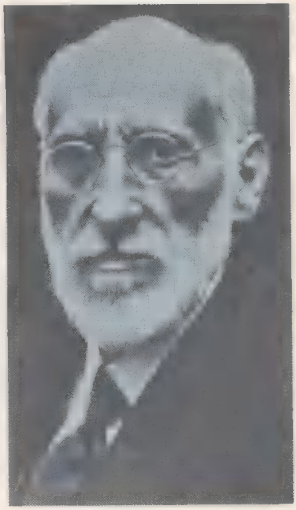
The zeuglodon got its name from the Greek words *zeugle*, meaning strap or loop, and *odon*, meaning tooth, a description of one of the creature's rear teeth. Zeuglodon, as a matter of fact, is not the creature's original name says Dr. Richards. "The original discoverer called it *Basilosaurus cetoides*, but as *Basilosaurus* indicates the animal was a reptile, it is really a misnomer. Hence, it was later called zeuglodon because of its teeth."

Ancestors of the zeuglodon probably evolved on land and then returned to the sea, reversing the path of their more distant fish and amphibian ancestors who had originally emerged from the sea and evolved into reptiles and mammals. Its front legs became small paddles, and its tail ended in horizontal flukes. One quick method of telling a sea-going mammal like the modern whale or the zeuglodon from the fish, which they superficially resemble, is by the placement of the tail fin or flukes. A fish's tail fin is always vertical to the body, while the flukes of a whale, or seal for that matter, are horizontal. The nostrils of the zeuglodon were placed near the front of the skull and were used for breathing air.

When hunting, the creature could probably lift a full third of its elongated body out of the water. The same sort of action can be seen in some species of dolphins or other small toothed whales today—the modern creatures which this giant of the Tertiary era most closely resembled.

A Science Milestone

Santiago Ramon y Cajal



KFS

Structure of the nervous system

by Jim McMillan

WHEN ten-year-old Santiago Ramon y Cajal was marched off to jail with his father's approval, few of the satisfied onlookers would have believed that the worst juvenile delinquent in town would turn out to be an honored scientist. But 40 years later, he stood before one of the world's most distinguished assemblies to accept the Nobel Prize in physiology and medicine.

The road to Stockholm was a hard one. It began in the tiny Spanish village of Petilla de Aragon, where Santiago was born on May 1, 1852, the son of a barber surgeon second class. Cajal himself said of his birthplace that, "rather than the home of hardy and happy peasants, it seems like a place of punishment and castigation." His father had come to practice there after a long struggle for self-education. Don Justo Cajal was an extremely capable man, gifted with a fantastic memory, but he had been forced

to finance his medical education in Barcelona by working as a barber.

At first, young Santiago showed few signs of wildness. His education began at four, and by the age of six he could not only read and write but also had acquired some knowledge of French, geography, and arithmetic. By that time his father had secured a better practice in the town of Valpalmas. There two events occurred which were to implant a deep feeling for science in the boy. The first took place in a classroom where Santiago and other children had gathered. A thunderstorm had begun, and the priest began to toll a warning on the church bell. Suddenly there was a terrible crash. The room filled with sulphury fumes and choking dust. Half-blinded, the children ran into the street. Over the railing of the bell tower lay the priest, his cassock aflame. The lightning bolt which had struck the belfry had shattered forever the safe, well-ordered world of Santiago's childhood.

Explanation of an Eclipse

This event was fortunately followed by another which helped restore order to the boy's world. There was an eclipse of the sun. When Don Justo explained how the sun would disappear and presently reappear, Santiago was distrustful. How could human intelligence, which had failed to warn of the lightning bolt, say what was going to happen at such a distance? But the eclipse took place exactly as predicted. Much later, Cajal recalled how this made him see that man had in science "a powerful and universal instrument of foresight and domination."

Off to Jail

Unfortunately for Santiago's education, his father took the family to Ayerbe, a village where the populace spoke a strange dialect and had very different ways from the people in Valpalma. The Ayerbe boys disliked the newcomer, who spoke pure Castilian and wore shoes rather than open sandals. Endless hazing followed. Santiago's desire for learning became second to his desire for self-respect, and he finally resolved to outdo the local boys in fruit stealing, vandalism, and slingshot warfare. After he outdid all his previous pranks by blowing a hole in a gate with a homemade cannon, he was sent to jail.

Education became even less attractive when Don Justo decided to send his son to a strict school in Jaca. Like many parents, the senior Cajal was determined that his son should have what he himself had been denied during childhood, whether the boy wanted it or not. Santiago had shown early promise as an artist. But after an itinerant church plasterer pronounced the boy's lively drawings to be talentless, the senior Cajal ruled out art. Moreover, in Jaca Santiago found that he loathed Latin. His angry teacher locked him into a room each

night until supper was over. The young rebel lost considerable weight, but not one bit of his defiance. The result was that he was eventually sent to another school in Huesca, where he found gentler teachers.

During his vacations Santiago did wonder about the world about him. At one time he compiled an extensive dictionary of colors, illustrated with flowers stolen from local gardens. Later, he began a bird's egg collection.

Romantic novels provided a first glimpse of the world beyond Ayerbe. Since works of fiction were held by his father to be poison for young minds, it is not surprising that Santiago learned to enter a neighbor's house through an upstairs window and "borrow" such books as *The Count of Monte Cristo* and *Robinson Crusoe*. Unfortunately, less creditable pranks led to his being taken from school and apprenticed to a barber and a cobbler in quick succession. Faced with what would be his life's work if he failed to complete his education, Santiago finally buckled down to study. The result was his admission to the University of Zaragoza.

At the time of Cajal's entrance, the university still held to an old-fashioned curriculum in which the sciences were a matter of rote learning rather than experiment. But it didn't matter. After the schools at Jaca and Huesca, his active mind was finally confronted with a very real challenge. He soon "discovered" physics, chemistry, and biology.

With the help of his pleased father, Santiago took advantage of the summer vacation to begin instruction in anatomy. One dark night father and son scaled a cemetery wall and sought out the pile where bones, exhumed to make room for new burials, were dumped. Arriving home with bags of bones over their shoulders, they proceeded to begin the study of the human skeleton. So apt a pupil was Santiago that, by the age of 18, he had compiled a first-rate atlas of osteology. His father wished to publish the work, but the state of the graphic arts in Zaragoza made the project unfeasible.

'He Must Have Cheated'

The young provincial was already astounding the university. When reprimanded for skipping lectures, Cajal gave such perfect answers to his professor's angry questions that he was excused from further attendance. Cajal's excellence soon led him into a competition. Although he won, one of the examining professors bitterly told him that he must have copied his answer because no student could know so much. This was the last competition the proud Spaniard ever entered.

After receiving his licentiate in medicine, Cajal went into the army as a medical lieutenant. Writers' descriptions of a green paradise had given Cajal the desire to see the tropics. He gladly accepted an as-

signment to Cuba. The island was less romantic than pictured. The Cubans were rebelling after 300 years of Spanish rule. Cajal's proud refusal to use his father's letters of introduction led to his being assigned to jungle pestholes where he came down with malaria. The pestholes were also outposts of rampant corruption. In Puerto Principe, for example, Cajal's complaints against profiteering in hospital kitchens resulted in the retaliatory stabling of horses in the hospital wards. When Cajal returned to Spain, disillusioned and in poor health, his sweetheart broke off their engagement, out of fear that he would soon die and leave her a widow. Through his father's care he eventually recovered most of his former strength, but not until he had contracted tuberculosis.

Devotee of the Microscope

When Cajal returned to Zaragoza, he was appointed temporary assistant in anatomy at the university at a stipend of $200 a year. With no up-to-date equipment available he used his own money to buy a modern microscope. His interest in histology—the microscopic examination of animal and vegetable tissue—had been stimulated by some cell slides he had seen as a student.

Today the value of the miscroscope seems absurdly self-evident, but at that time many professors contemptously labelled microscopic observation "Celestial Anatomy." Interested only in what he saw, Cajal became a devotee of the microscope. Once he spent 20 hours at the eyepiece, patiently watching a leucocyte try to escape from a capillary.

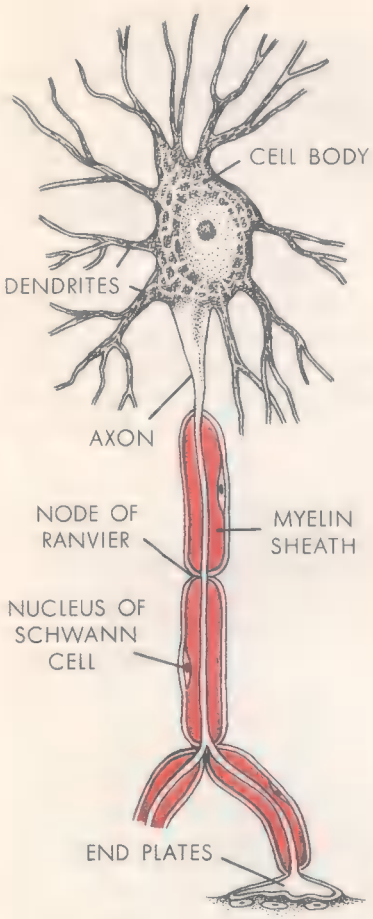
Ignored by Spanish Science

In 1880, the year of his appointment, Santiago married Dona Silvera Fananas Garcia. That year he also published his first discoveries. These caused little stir in the stagnant world of Spanish science. The newcomer was dismissed as presumptuous.

Undaunted, he subscribed to as many journals as his tiny salary would allow in order to learn what researchers outside Spain were doing. When he won a professorship at the University of Valencia Medical School, one of his first requests was for funds to allow his students to do laboratory work.

In the next few years, he published articles on the structure of the cartilege, the lens of the eye, and the structure of muscle fibers. His great work, the enormous *Manual of Normal Histology and Micrographic Techniques*, was a success in spite of its size and cost. A more adequate budget enabled him to slice specimens with a modern microtome instead of his old-fashioned barber's razor. Cajal's long latent artistic tendencies also found expression in a series of popular science articles.

At this time a cholera epidemic had produced some important re-



The nerve cell that carries electrical impulses to muscle fibers is called a motor neuron. The cell body branches out into a number of dendrites at one end, into the long axon at the other. Cajal discovered that dendrites of one cell contact, but do not actually fuse with, the axons of other cells. Nerve impulses from the cell body travel through the axon to the motor plate endings in the muscle. The axon is wrapped in the Myelin sheath which is formed by Schwann cells. The sheath insulates the axon and increases the speed of transmission of impulses to the muscle.

search. A doctor named Ferran had developed a system for immunizing people against cholera by subcutaneous innoculation with live bacilli. Cajal discovered that the problem was not so simple. The introduction of a small amount of live bacilli under the skin did not necessarily build up a resistance in the intestinal tract. Cajal also doubted that the reaction to the cholera bacillus was the same in man as it was in Ferran's rabbits and guinea pigs. The difference in human and animal reactions is still very much a problem.

A Bigger Budget

A vacancy in the Chair of Histology at the University of Barcelona tempted Cajal away from Valencia, offering greater freedom and a bigger working budget. Once established in Barcelona, at the old hospital of Santa Cruz, he gave his time to the study of the human nervous system.

Microscopic investigation of the brain was difficult because of the lack of suitable staining techniques. Some years before, the Italian microanatomist, Golgi, had perfected a silver stain in which the nerve fibers were impregnated with potassium bichromate. When "developed" with silver nitrate, the fibers stood out black. This system, however, was so undependable that even Golgi himself found it unsatisfactory. Cajal had the inspiration of trying it out on the nervous tissues of the embryo, in which the nerves are not

yet surrounded by the fatty myelin sheath. His experiment met with complete success.

At the time of Cajal's improvement, a controversy was going on about the structure of the nervous system. The nerve cell, or neuron, is typically composed of the cell body; a single, very thin fiber which may be several feet long, called the axon; and one or more dendrites, or shorter branches. A German, Joseph von Gerlach, had come up with the theory that all of the nerve cells of the grey matter were fused together at the ends of their processes to form a continuous net or reticulum. Golgi and the great majority of experts agreed. When two little-known scientists, Wilhelm His and Auguste Forel, hypothesized a theory of free endings, only a few paid attention. Cajal was certain, however, that His and Forel were right. For Cajal, a brain in which all elements were fused would be a thing of almost mystical complexity.

No Actual Fusing

Rather than waste his breath arguing, he then sat down to his microscope, employing his refinement of Golgi's own staining method. Nerve cells were revealed to him in their entirety, pointing out their relationship with other cells. The axons were indeed pressed up very closely against the dendrites and bodies of the nerve cells, establishing a contact without actually fusing. The brain was not a dark, trackless forest, but a series of pathways.

Unfortunately the work in the laboratory was only half the battle. No one in Spain was willing to listen. Armed with these demonstrations and specimens Cajal set out for the 1889 Berlin congress of anatomy. There the German scientist, Kolliker, changed his own opinion on the matter and extended the unknown Spaniard the aid of his impressive reputation. Most experts were soon eager to be convinced.

Relied on Observation

Forgetting the controversy, Cajal began to study the embryonic development of the nervous system. Here too, there was dissension. One group believed that the neuroblast, or embryonic nerve cell, produced the axon by giving off a bud. The other believed that either an incomplete division took place or that independent neuroblasts joined to form the axon, like beads stringing themselves together. Again Cajal relied upon observation, rather than theory. He saw a bud or growth cone extending outwards from a neuroblast. Describing his discovery in vivid language, he called it "a living battering ram, soft and flexible, which advances, pushing aside mechanically the obstacles which it finds in its way."

A year later, he began to formulate his theory of dynamic polarity. Axons, the long, thin fibers, carried impulses away from the cell body, while dendrites always carried them

cellward. In other words, the neuron was a one-way street, impulses always being transmitted from the axons of one cell to the dendrites of another. This principle was demonstrated mainly on the retina of the eye, as it was clear that all visual information would be travelling in a single direction from the eye to the brain.

In 1892, after being appointed to the chair of Normal Histology and Pathological Anatomy in Madrid, Cajal was called to London to lecture before the Royal Society. He was awarded degrees and prizes in a mounting tide that caused him to remark that many persons would respect your wife, your honor, your fame, and your money, but not your time. His coolness failed to stem this tide. In 1899, while he was studying the nature of the optic chiasma, where the nerves from the eyes intersect on their way to the brain, he was called to America to lecture. This was a surprise, since the Spanish-American war was barely over.

The summons to Stockholm came in 1906. In his modesty Cajal seriously considered declining. Friends had great difficulty convincing him that this was not done. He did eventually accept and went to share the honor with his old rival, Golgi. When he returned to Spain he was again forced to desert his laboratory bench for the banquet tables.

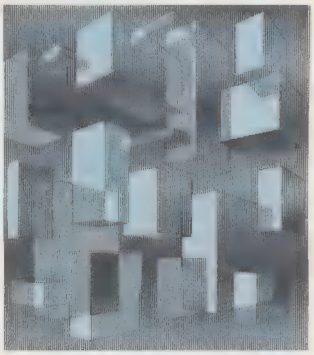
Over the next eight years, Cajal made his historic studies on the degeneration and regeneration of nerves. How was nervous activity restored after a nerve had been severed? He found that several days after the separation new branches grew in all directions from the ends of the fibers in the stump. While some of these grew through the scar to form the regenerated nerve, the others, failing to reach any objective, gradually degenerated.

World War I saw the death of many of the men who had championed his work. New, younger scientists who could not read Spanish were constantly "discovering" phenomena already described by Cajal in Spanish publications. Cajal retired from teaching at 70, believing this was a job for younger men.

Discoveries Confirmed

He continued his research work until shortly before the time of his death. Some of this new free time he used to write an excellent autobiography. Living longer than he had expected, he was forced to write a sequel, *The World At Eighty Years,* in which he described the changes which aging in general and arteriosclerosis in particular had produced in his own self.

When he died in 1934, he was universally honored, but his countrymen in particular realized that Santiago Ramon y Cajal had done more than any one man to lead Spanish science out of the disrepute it had suffered for centuries. The neuron theory survived him to be reconfirmed by the electron microscope.



INVENTIONS PATENTS PROCESSES

Sound Teaching Projector Requires No Film Handling

A cartridge-loaded sound film system that requires no film handling has been developed for the classroom.

According to the developers, Fairchild Industrial Products, 580 Midland Ave., Yonkers, N.Y., the new system represents an entirely different way of packaging and projecting films. The system includes an 8 mm rear screen sound film projector and a plastic program cartridge, about the size of a paperback book, which contains the 8mm magnetic sound film.

For the first time in a sound film projection system, no film handling, threading or rewinding is required, the company says. To operate the system a teacher or student merely inserts the program cartridge into a slot at the front of the projector and presses an operating lever. While the film is being projected, it is also being rewound in the program cartridge. An automatic control turns the projector off at the end of the film. The projector is completely portable, weighs 20 pounds, and measures 13 by 14½ by 16 inches.

The program cartridge can hold up to 400 feet of 8mm color sound film for a maximum projection time of 22 minutes or up to 30 minutes in black and white. When it is not being projected, it can be kept in a cardboard jacket and stacked or stored on shelves, much like books or records.

The system, known as Cinephon-

The Fairchild Cinephonic Mark IV system is designed for both individual and group classroom teaching situations. The program cartridge can be inserted directly into the projector and it is ready for use in seconds. Controls include focus, framing and volume control. Larger screens are available for showings for large groups.

ic Mark IV, will be offered as a complete educational package and the company is now negotiating with a number of producers of educational film series. First to be made available will be a series, originally prepared for educational television broadcasts by station KQED of San Francisco to train teachers to teach Spanish. This series is offered first because of a new California state law which requires the teaching of foreign languages in the elementary schools.

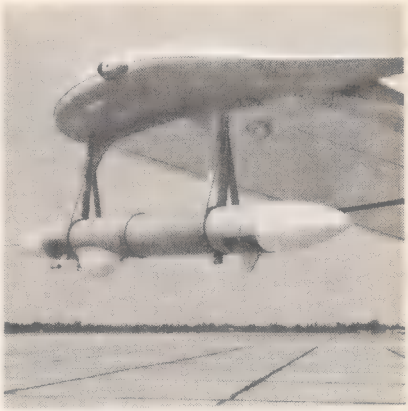
Any television program that is recorded by kinescoping or videotaping can be transferred to 8mm sound film and loaded into program cartridges. In addition to the large amount of television material available, there are other educational film libraries, covering a large number of subjects in both color and black and white, which can be adapted for the Cinephonic system, the company says.

While school use appears to be the most immediate market, the system also lends itself to industrial instructional use and for training systems which appear to be particularly appropriate to the military.

An optional plug-in headset allows the projector to be used by an individual without disturbing others who may be studying or reading in the same area.

Planes Carry 'Weather Pod' To Aid in Forecasting

A miniaturized "weather pod" that can be carried aboard any small aircraft, has been developed by the Bendix Corp.



The bomb-like unit installed on the tip of the plane wing is a new meteorological device designed by the Bendix Corp. to measure temperature pressure, and precise dewpoint for weather forecasting. It can be installed in a drone plane and flown directly into a severe storm to take measurements.

The equipment, known as the Bendix M-9 Meteorological Pod (MET-POD), will measure pressure, temperature, and precise dewpoint, three key meteorological variables for research and weather prediction. These measurements are then relayed to ground-receiving equipment by an ultra-high-frequency meteorological telemetering radio band.

The unit has a self-contained battery supply, enough for a two-hour operation, that makes the pod independent of the carrier vehicle.

The pod may be carried under the wing of a plane up to altitudes of 40,000 feet, and into any geo-

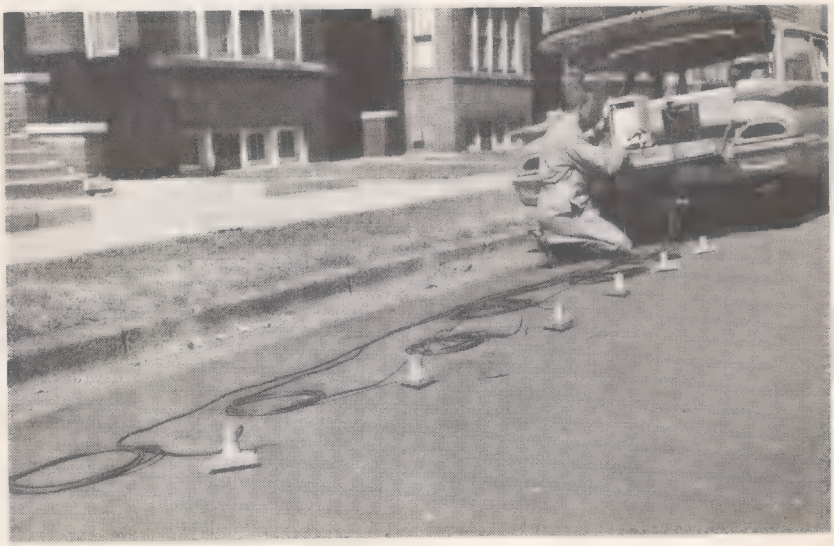
graphical area. It is 61¼ inches long and 4 inches in diameter, and weighs 18¾ pounds. The equipment was designed and developed at the meteorology and geophysics department of the Bendit division in Ann Arbor, Mich.

Colored Card May Replace Parking Meter

An inexpensive chemical timer—in the form of a colored card a motorist could apply to the inside of his windshield—may someday eliminate expensive parking meters.

The idea for the new timer, which he describes as a "kind of a parking stamp," was conceived by Felix D. Kolben, of Chicago. Kolben took his idea to Armour Research Foundation of the Illinois Institute of Technology for technical development. An ARF chemist, Dr. L. F. Biritz, successfully developed the "parking stamp."

A chemically coated dark green card encased in transparent plastic, the timer stamp has a tiny pin hole at one end covered with a short strip of adhesive. To start the "meter," a motorist would simply peel off the adhesive, letting air into the card. With an "hour" stamp,



Detection of leaks in gas mains without disturbing large areas of street surface has been made possible with this sonic detector. Developed by the Illinois Institute of Technology, the device is portable and can be put into operation quickly. When a leak in a main is suspected, a pure sonic tone is induced into the gas, and electronic transducers placed along the surface detect sound waves emanating from the leak. Grouping of transducers after general location is determined permits accurate pinpointing of the leak for efficient excavation and repair.

the dark green card, in 60 minutes time, would turn a pale yellow, almost white.

Kolben suggests that his timer stamp, if put into general use for the control of municipal parking, would save local governments much of the high costs they now bear for meter purchase, installation, maintenance, and coin collection.

Using the timer stamp parking plan, local officials would need only to post signs designating an area as a parking zone and cite the parking rate for that particular zone.

Since only minor expense would be involved in setting up these parking zones, parking stamps would make it possible for governments to adopt flexible parking regulations for areas where parking problems are seasonal, such as beaches, picnic spots, fair grounds, and stadiums.

Kolben also believes his timer would be welcomed by change-short motorists as a replacement for parking meters. By keeping a supply of the timer stamps in his car, the motorist would avoid the sometimes fruitless search for small change now necessary each time he pulls into a conventionally metered parking space.

If a motorist wanted to move his car from one parking space to another, he would be able to make use of the unconsumed parking time on his stamp in his next parking space instead of leaving paid but unused time on a meter to be salvaged by the next occupant.

While Kolben stresses the potential of his timer stamps to replace costly parking meters, he also believes the device could have many other applications; on packages of heat-and-serve precooked foods, for instance, and in numerous industrial operations.

Feathers Ground to Meal For Chicken Feed

Modern technology is encouraging a sort of cannibalism in chickens, and it has turned a costly nuisance into a million dollar industry. In preparing oven-ready poultry, vast quantities of feathers plucked from chicken and turkey carcasses piled up at the processing plant. Scientists at the U. S. Department of Agriculture's Western Utilization Division at Albany, Calif., are converting the feathers by pressure cooking and grinding them into a stable, friable, high-protein meal which is then mixed with other ingredients and used to feed new generations of birds.

The feathers are now the basis of an expanding industry currently worth $12 million a year.

Kit Makes Fishing Floats For Every Purpose

A kit containing seven plastic segments from which 24 different fishing floats can be quickly assembled is being marketed by Angling Development Ltd., 59 Bridge Gate, Derby, England.

The kit consists of three top sections or tips, three center sections

or buoyancy chambers, and one bottom or shot chamber. From these sections everything from a featherweight float for float fishing to a heavy float for live bait fishing can be assembled.

Five Story Fireless Fireworks Display

A simulated fireworks display five stories tall is offered by Mobilcolor, Inc., 232 E. 53rd St., New York 22, N.Y. Called "Electronic Fireworks," it produces the brilliant effects of bursting skyrockets and cascading points of multicolored light for approximately six minutes before any pattern is repeated. Synchronized with the display is tape recorded music and the various sound effects associated with authentic fireworks.

'Fail Safe' Bolt Will Withstand Aircraft Vibration

A bolt that will spring-lock immediately in place should its nut vibrate off in aircraft, missile, or space vehicles has been developed by the Lockheed-California Co.

Invented by engineer Charles D. Steward, the new "fail-safe" bolt is said to be as simple as a paper clip.

The bolt features an integral, hairpin-type spring clip with legs which compress into grooves in the threaded portion of the bolt when the nut is tightened. Should the nut loosen, the legs merely expand so that the bolt cannot slip from its mounting hole.

According to Lockheed, tests have shown that the spring clip bolt will be more reliable and foolproof than safety devices now in use, cotter key-pins, safety wires, and lock nuts.

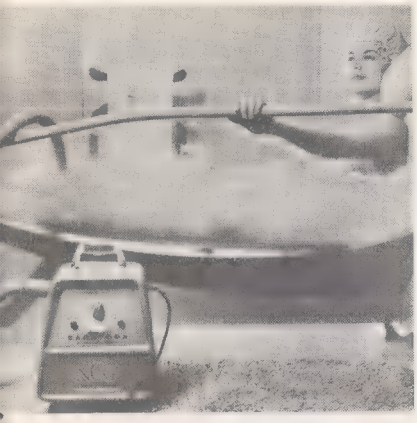
However, it is likely the standard safety devices would be used along with the spring clip bolt, thereby doubling the protection and precautions against vibration.

Home Hydro-Massage

A portable unit designed for home or institutional use can convert a bath tub into a hydro-massage.

Although no moving parts or machinery of any type are placed in the tub, the bath water is whipped to a relaxing froth of swirling bubbles. Called the Saratoga hydro-air massage, the system consists of two units—a high-speed impeller type blower with timer control in a steel-and-plastic cabinet, and a hollow molded plastic platform that can be placed on the bottom of any standard-size bathtub.

Air pressure is forced by the blower through a flexible tube into the hollow platform, emerging through perforations in the platform into the water. Speed is adjustable for "relax" or "massage." The power unit, approved by Underwriters Laboratories Inc., is iso-



A special transparent bathtub shows the operation of a hydro-massage unit. A high-speed blower forces air through a flexible tube and out perforations in the platform in the tub. Any standard-size tub will do; it doesn't have to be transparent.

lated from the user and tub; the 115-volt motor is insulated from the case which, in turn, stands on rubber-tipped legs. A grounding lead is also supplied.

The user's head is supported by a wetproof inflated pillow that attaches to the wall of the tub with suction cups.

The system is distributed through the National Cylinder Gas Division of the Chemetron Corp., 840 N. Michigan Ave., Chicago 11, Ill.

Portable Diving Board

The new Torsion Flite diving board is a self-contained, portable unit measuring 42 inches overall. It is made of torsion steel, topped by a laminated fir board heavily enameled, with a regulation safety tread molded in place. All bushings are vinyl and metal parts are cadmium plated to prevent corrosion. No anchoring is required, according to Goodhue Enterprises, 190 Central St., Leominster, Mass.

Space-Bird Kite

Space Bird, a three dimensional kite with wings that flutter to simulate the wings of a bird is being offered by the Halco Co., 165 Dwight St., New Haven 2, Conn. The kite is made of tear-proof acetate cloth in three brilliant colors and needs no tail or running to launch. The giant size Space Bird has a 48 inch wing spread and is 33 inches long. The kite comes

The Space Bird kite flutters its wings in the air. Made of sturdy acetate cloth, it needs no tail or running to launch.

complete with 250 feet of cord. For the ultimate in kite flying there is the super size Space-Bird with its 66 inch wing spread and 47 inch length. This kite comes complete with 500 feet of cord and a wooden winding reel.

Nest for Bird Watching

A plastic wren house that attaches to a window and allows bird watchers to look in the nest without being seen by the birds, has been developed by the Vu-a-nest Co., Box 21, Granite City, Ill. The nest attaches to the window glass by means of a shock absorbing tape which helps keep noise from the owner's home from disturbing the birds. The nest can be removed from the glass without damage.

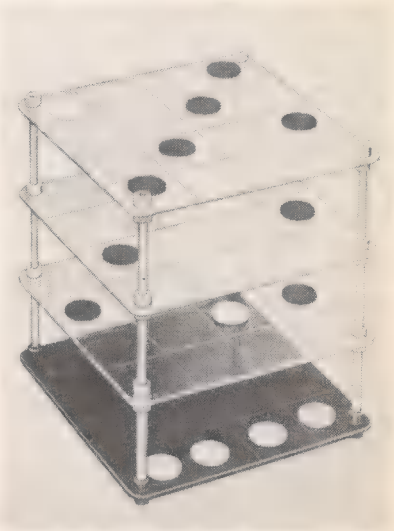
The back of the wren house is a one-way mirror that permits the viewer inside his home to see what is going on in the nest without being seen by the birds. The vu-a-nest is constructed from polystyrene plastic, a good insulator that resists mildew and rot.

Weather Forecasting Kit

Weather conditions can be studied at home through the use of the Weather Research Laboratory brought out by Revell, Inc. of Venice, Calif. Easily assembled, the kit contains a rain gauge, sling psychrometer with two five inch thermometers, anemometer, aneroid barometer with completely assembled mechanism, nephoscope, compass and wind gust indicator. A booklet on the weather also is included.

3-D Tic Tac Toe Game

Qubic is a four-in-line tic tac toe game played in three dimensions. The object is to get four markers in a straight line: across, diagonal on the same level, up and down, slanting, and from top to bottom corner, one marker on each level. Players in turn, place a marker on any of the 64 spaces. Two or three play, or four can play as partners. The game is made entirely of plastic and is available in department and toy stores and from the manufacturers, Qubic Games, West Ox Bow Road, Shelburne Falls, Mass.



Plastic Qubic three-dimensional tic tac toe game with markers arranged to show the winning lines.

SCIENCE DIGEST QUIZ

1. In 1873 the British oceanographic ship **Challenger** made soundings which gave the first indication of the existence of the mid-Atlantic Ridge. At this time only primitive sounding techniques were used. How were the soundings made?
2. Today soundings are made with a device called a Precision Depth Recorder. How does this instrument work?
3. The British physicist P.A.M. Dirac has proposed that the force of gravity decreases as the universe grows older. With the relaxation of the force holding the material of the earth together the earth could expand. What evidence have oceanographers found that seems to support this theory of an expanding earth?
4. Hovercraft vehicles ride two or three feet above the surface of the earth or water on a cushion of air. How is this air cushion contained beneath the vehicle?
5. The Van Allen radiation belts that surround the earth can be altered by nuclear explosions high above the atmosphere. What natural event also produces major changes in the belts?
6. The artificial addition of electrons to the radiation belts by high altitude nuclear explosions was predicted by scientist N. C. Christofilos. When was the truth of this theory first demonstrated?
7. The fossil whale found in Washington County, Alabama, was only a few feet beneath the surface, although it was tens of millions of years old. Why was it so close to the surface?
8. The history of Shechem can be read in the Old Testament but no dates are given. Now archaeologists excavating this ancient city have begun to date the various phases of its history. What is the earliest date at which they place the altar and sacred oak at which Abraham and Jacob worshipped?
9. Although Santiago Ramon y Cajal won the Nobel prize in 1906 for his work on the nervous system, younger scientists were constantly "discovering" phenomena already described by him. What was the reason for this?

For answers see the following pages:

1) p.5; 2) p.5; 3) p.12; 4) p.65; 5) p.58; 6) p.59; 7) p.78; 8) p.43; 9) p.87.

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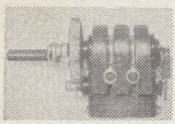

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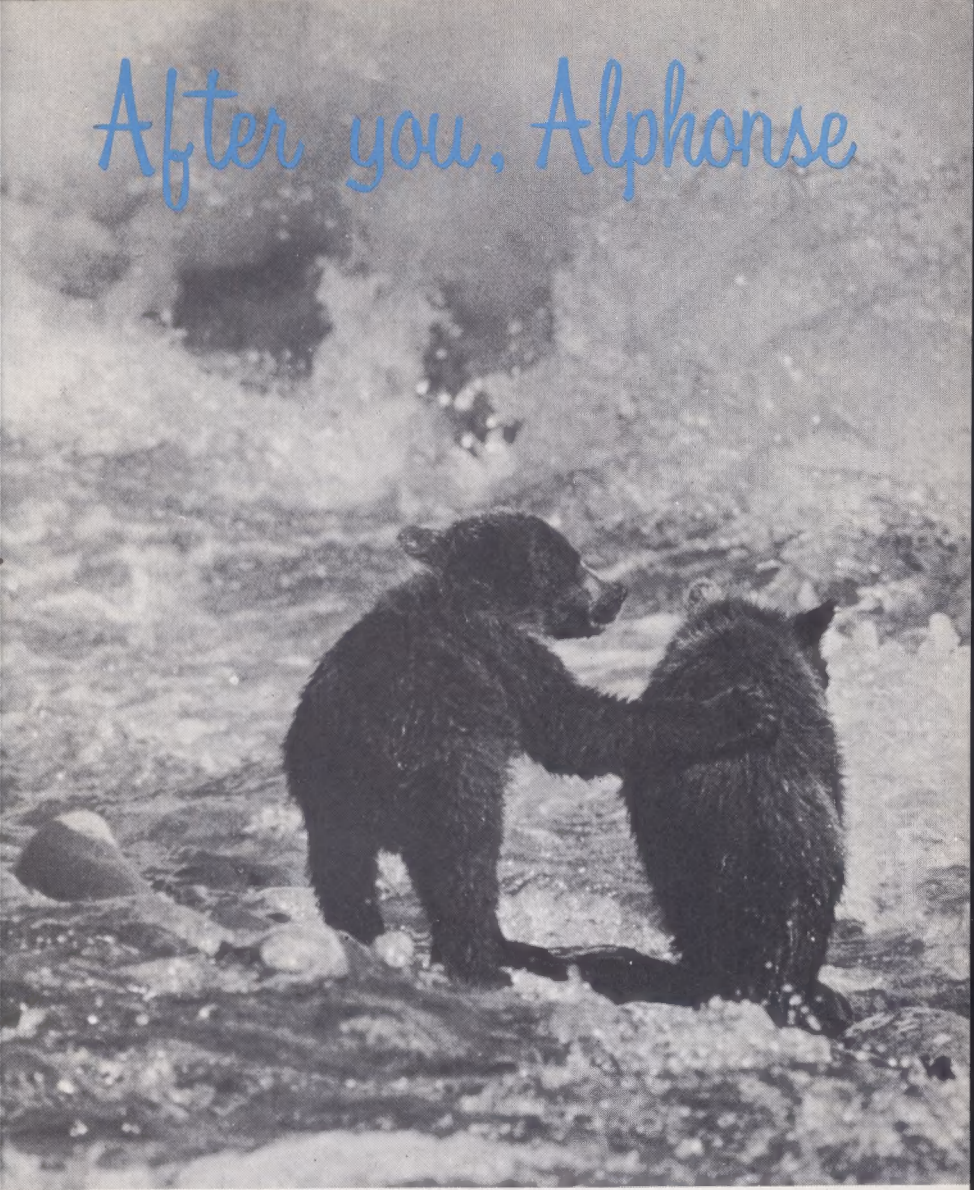

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Two brown bear cubs hesitate as they consider wading further into the turbulent water of a stream. Brown bears, solitary creatures during most of the year, gather at streams in large numbers when the salmon run in July and August. These cubs are still too small to fish successfully for themselves, and would probably lose a contest with a vigorous salmon.

SCIENCE DIGEST

TAKING A TELESCOPE to the edge of space in a balloon is the object of Project Star Gazer. Flight-suited, astronomer William C. White, stands alongside the Star Gazer gondola before a recent test flight. White and Capt. Joseph W. Kittinger, one of the nation's top balloonists, were carried to a height of 81,800 feet beneath a 230-foot helium filled balloon. Mounted atop the gondola was a 12½-inch reflecting telescope. With this instrument, astronomers hope to observe the stars and planets for the first time without the intervening veil of the atmosphere. Kittinger holds the world's record for the longest free fall and parachute jump. White has never used a parachute. He said, however, that a chance to look at the stars from above the atmosphere was worth the possibility of a jump to any astronomer.